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ADMINISTRATIVE INFORMATION

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EXECUTIVE SUMMARY

OBJECTIVE

The performance of a field-portable x-ray fluorescence (XRF) spectrometer on board a small research vessel was evaluated for the near-real-time determination of metals in marine sediment.

APPROACH

Analyses were performed using a Spectrace 9000 portable XRF spectrometer. Manufacturer-supplied application programs were used, with suitable modifications made to counting times. An analysis of certified reference soils and sediments in the laboratory verified the accuracy, precision, and detection limits of the instrumentation. The instrumentation was then installed on board a small research vessel and used to measure marine sediments, obtained with a sediment grab, along transects in San Diego Bay. Subsamples of these sediment grabs were taken to the laboratory and processed for XRF measurement using standard laboratory techniques for quantitative analysis. We had the following objectives: (1) to explore the variation of replicate wet samples from the same sediment grab; (2) to compare the analysis of the natural wet samples with dried, homogenized samples; and (3) to demonstrate the feasibility of obtaining very rapid metals analyses on site.

RESULTS

There was no difference in data quality between wet samples analyzed at sea or analyzed in the laboratory, indicating that the operating environment did not affect instrument performance. There was more variation of concentration in trace metals in replicate wet samples than in replicate dry samples, because the latter were well ground and mixed after drying. However, the relative standard deviation between both replicate wet and dry samples was very close to the relative standard deviation of each measurement. This investigation demonstrated that the XRF spectrometer can be used to rapidly screen for metal contamination with a minimum of sample handling and preparation.

CONCLUSIONS

XRF provides precise and rapid measurements at detection levels relevant to concentrations indicative of pollution for a wide range of metals. A field-portable XRF spectrometer can perform well on board survey vessels and generate data from sediment grabs in a time frame that could guide on-site decision-making for mapping strategies and detailed sampling. Areas can quickly be reinvestigated if necessary. Since XRF spectrometry is a nondestructive technique, additional or confirmatory analysis of the same sample by an analytical laboratory is possible.

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INTRODUCTION

Since heavy metals are among the more toxic pollutants in the environment, metal contamination in soils and sediments is an important environmental concern. Lead, for example, was identified as a major contaminant at about 30 percent of 546 evaluated Superfund sites; and arsenic, cadmium, chromium, and zinc were each of concern at about 15 percent of the sites (Watson, Walsh, & Glynn, 1989). Heavy metals can reach the estuarine environment from boating operations, from rivers draining densely populated and heavily industrialized areas, and from nonpoint source runoff.

Rapid, simultaneous, multielement analysis can be performed using x-ray fluorescence (XRF) spectrometry. XRF spectrometry is an extremely versatile nondestructive analytical technique, which measures the emission of characteristic x-rays that occurs when atoms are excited by an external source of radiation. The energy and intensity of these x-rays identify and quantitate the elements that are present. XRF spectrometry is capable of analyzing a wide range of elements, usually from sodium to uranium, and has a dynamic range from ppm to 100 percent, which encompasses typical element levels in soils. Minimal sample handling is required, and the technique is economically attractive because it consumes no extra materials, such as solvents or acids, and thus generates no additional hazardous wastes. Since the measurement is nondestructive, key samples can be reanalyzed or measured by a different confirmatory technique.

Until recently, most XRF instruments were large heavy units that occupied significant floor or bench space in a laboratory. Thus, samples had to be collected in the field and brought back to the laboratory for analysis. Commercially available, truly field-portable instruments are an emerging tool for the in-situ analysis of metals (Chudyk, 1989).

XRF spectrometry has been used for the analysis of both soils and sediments. Watson and his coauthors (1989) used an on-site XRF spectrometer to map metal contaminants at Superfund sites. Wheeler (1993) discussed the use of XRF spectrometry in rapid, multielement determinations of contaminated soil, as well as of hazardous waste fuels. In addition, Raab et al. (1991) used a field-portable XRF spectrometer to map lead concentrations in situ at a contaminated site.

Vanderstappen and Van Grieken (1976) determined trace metals in sea sediments by producing a slurry of water and sediment, then filtering the material onto Nucleopore filters and determining trace metals on thin films. Their work showed an influx of heavy metals from rivers draining heavily populated and industrialized areas. Skei et al. (1972) analyzed bottom sediments in a Norwegian fjord by drying and homogenizing the material to show the levels and distribution of heavy metals around the source of industrial wastes. Prototype in-situ XRF sea floor measurements at 100 meters were investigated by Wogman and his coauthors (1975) to determine the applicability of the in-situ XRF analysis of seabed pollutants. The thickness and strength of the required beryllium window seemed to be the limiting factor of the instrumentation.

The object of the present study was to evaluate the performance of a field-portable XRF spectrometer for marine samples both in the laboratory, and more important, on board a small research vessel for the near-real-time determination of metals in marine sediments. A comparison of the results obtained from the wet, bulk samples in the field and from the dry, homogenized samples in the laboratory was of particular interest.

MATERIALS AND METHODS

Materials were analyzed by using a Spectrace 9000 portable XRF spectrometer (Spectrace Instruments, Inc., Mountain View, CA; manufactured by TN Technologies, Round Rock, TX). The instrument contains three radio. otope sources—Fe-55, Cd-109, and Am-241—to provide the excitation x-rays, and an electronically cooled solid-state mercury iodide detector (Singh, 1982) to measure the characteristic fluorescent x-rays. Manufacturer-supplied application programs were used, with suitable modifications made to counting times. The performance of the portable XRF spectrometer was tested in the laboratory against certified reference materials.

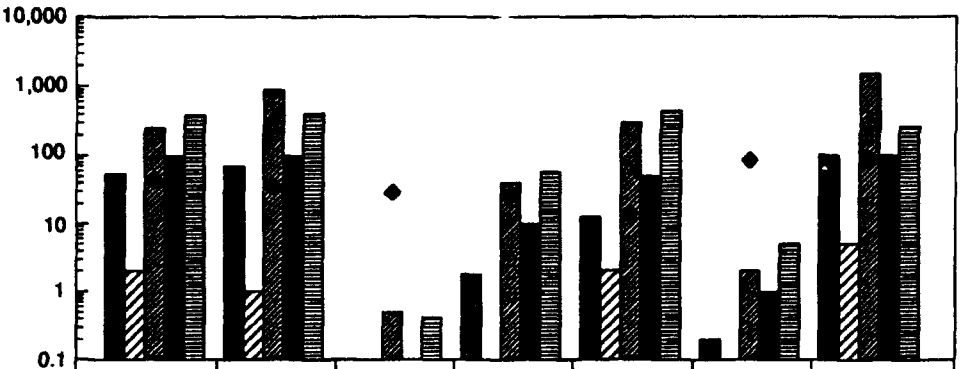
Marine sediment reference materials for trace elements PACS-1 and BCSS-1 were obtained from the National Research Council of Canada (Ottawa, Canada). San Joaquin Soil 2709, Buffalo River Sediment 2704, Montana Soil 2710, and Montana Soil 2711 were obtained from the National Institute of Standards and Technology (Gaithersburg, MD). In measuring these samples by XRF spectrometry, live count times of 100 seconds were selected for each of the radioisotope sources.

On 1 July 1993, the portable XRF spectrometer was subjected to sea trials on board a small research vessel, R/V *Ecos*, to demonstrate the near-real-time measurement of metals in San Diego Bay. A Van Veen sediment grabber was deployed at five stations along three transects—A, B, and C—near the site of Navy operations. The sediments were drained, dumped into stainless steel trays, and stirred with a Teflon paddle. Three aliquots of the sediment were poured into x-ray cups (Spex Industries, Inc., Edison, New Jersey), fitted with Mylar ends, and analyzed for 25 elements while the vessel was underway. Live count times of 20, 100, and 100 seconds for the Fe-55, Cd-109, and Am-241 sources, respectively, were used to analyze the sediments. A portion of the sediment was also collected in plastic tubes and frozen for subsequent analysis. The defrosted sediment was dried at 110° C overnight, finely ground with mortar and pestle, and reanalyzed in the laboratory. On 2 July, sediments were collected by colleagues on two more transects—D and E—and along a cruise track, F, in a study region. These samples were stored frozen in plastic tubes. The wet samples were defrosted, analyzed in the laboratory, then dried, homogenized, and analyzed again.

The locations where the samples were taken and their physical states are reflected in the designations of specific samples. For example, D12W is a sample from transect D, station 1, and is the second replicate measured while wet. D12D is a dried sample from the same location. D12W and D12D are subsamples of the same mixed sediment grab; they are not the same sample before and after drying.

RESULTS

Complex environmental issues, such as the extent and type of contamination, can be resolved with rapid on-site analyses. On-site decision-making can save a great deal of time, money, and effort. The portable XRF spectrometer has the potential of being ideal for field-screening soils and sediments because the analysis is rapid and covers a wide selection of elements over a large concentration range. Figure 1 illustrates this capability by comparing the stated detection limits, DL XRF, for XRF spectrometry (TN Technologies, 1992) with the concentrations of selected trace elements shown as average crustal abundances (CRC Handbook, 1992), low and high



	Cu	Zn	Hg	As	Pb	Cd	Cr
AVG CRUST	55	70	0.08	1.8	12.5	0.2	100
LO NP SOIL	2	1	0.01	0.1	2	0.01	5
HI NP SOIL	250	900	0.5	40	300	2	1500
SQC WI	100	100	0.1	10	50	1	100
SQC WA	390	410	0.41	57	450	5.1	260
DL XRF	44	35	29	25	14	86	90

Figure 1. Trace elements in sediments.

concentrations in nonpolluted (NP) soil (Baudo, Giesy, & Muntau, 1990), and sediment quality criteria (SQC) for Wisconsin (Baudo et al., 1990) and Washington State (Burton, 1992). Copper, zinc, mercury, arsenic, lead, cadmium, and chromium were chosen for comparison because of the availability of certified data. For most of these elements, the detection limits of XRF spectrometry are below naturally occurring or desirable levels. However, for mercury, cadmium, and probably arsenic, XRF spectrometry had poor detection limits and can only be used to determine elevated concentrations of those elements at highly contaminated locations.

The particular instrument we used is ruggedly packaged for field use and entirely self-contained. The instrument is compact and consists of a multichannel analyzer (13 by 14 by 4 inches) connected by a 6.7-foot cable to the probe assembly, which can be hand-held or mounted upright for benchtop operation. Its total weight of less than 20 pounds and small size make it truly field-portable. The instrument can provide fast, simultaneous analysis of up to 25 user-selected elements.

The most important shortcomings of XRF spectrometry are the so-called matrix and particle-size effects. These interfering effects, which can seriously limit the accuracy of analysis, consist of variations in the fluorescent intensities of the excited elements due to the chemical composition and granulation of the sample. We performed quantitative analysis using a built-in Fundamental Parameters (FP) program, based on the method of Criss, Birks, and Gilfrich (1978). FP purports to eliminate the need for a large number of standards or for site-specific standards by automatically correcting for any matrix enhancement or absorption effects based on stored physical constants. The second problem of grain size, although a subject of much theory (Lubecki et al., 1968), is usually handled by the slow and laborious steps of drying, grinding, sieving, and possibly pelletizing the samples.

The performance of the portable XRF spectrometer was first tested on certified reference materials in the laboratory. Since certified marine reference sediments are few in number, we

added a river sediment and several soil samples to the experiment. PACS-1 and BCSS-1 are marine reference sediments with high and low trace metal contaminations, respectively. Standard Reference Material 2704 is Buffalo River sediment; Standard Reference Material 2709 is San Joaquin soil, both with baseline trace element concentrations. Standard Reference Materials 2710 and 2711 are Montana soils with highly elevated and moderately elevated trace element concentrations, respectively.

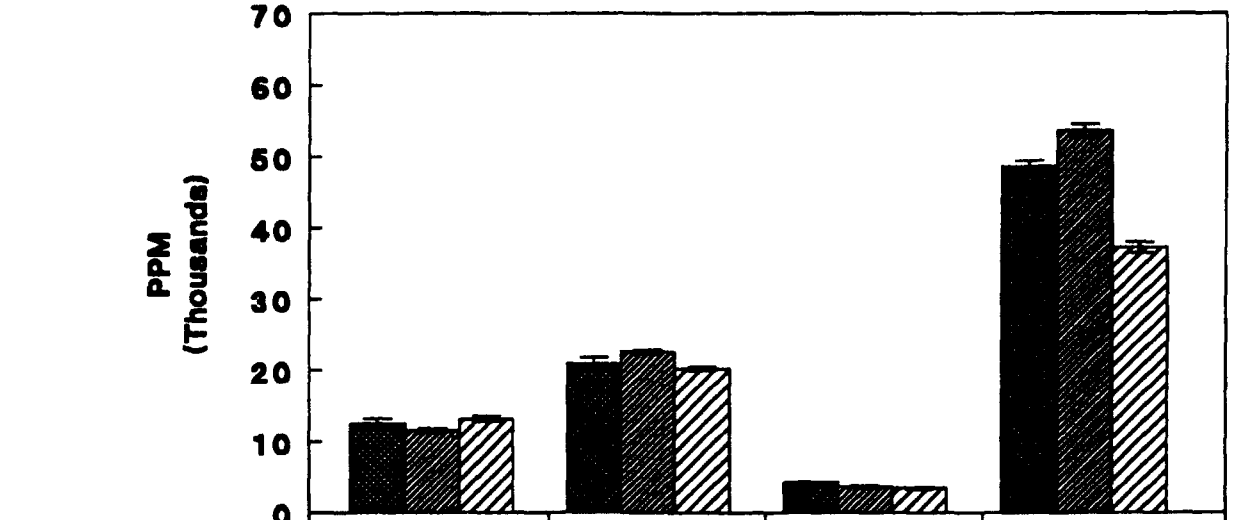
Figures 2a through 2f show the certified concentrations versus the results of XRF measurement for the major elements—calcium, potassium, titanium, and iron—using two manufacturer-supplied application programs for soil, XRF-1 and XRF-2. The error bars indicate the standard deviations of the measurements. The concentration levels were much higher than the stated detection limits for the XRF spectrometer. Generally, the measured results were close to the certified concentrations. The first application program was developed for laboratory-processed samples; the second application program contains modifications for field use to accommodate irregularities in naturally occurring grain size distributions and is known to produce low results for some element concentrations with finely ground materials (personal communication, TN Technologies).

Figures 3a through 3f show the results for copper, zinc, and lead in the reference sediments and soils. These elements were selected for comparison because they were certified in all the reference materials and are of environmental concern. Note that the ordinate axis changes scale on these figures so that the error bars are not misleading. The reported detection limits for copper, zinc, and lead in soils by the Spectrace 9000 XRF spectrometer are 44 ppm, 35 ppm, and 14 ppm, respectively. Certified concentrations of copper and lead in BCSS-1 and Soil 2709 were below the detection limit, as reflected in figures 3b and 3d. PACS-1, Soil 2704, Soil 2710, and Soil 2711 showed good agreement between the certified values and the XRF values obtained with both application programs, as shown in figures 3a, 3c, 3e, and 3f, respectively. Variations between certified and measured values may be the result of grain distributions or experimental error in the preparation of sample measuring cups. Because of this generally good performance with certified reference materials, we were optimistic of good field performance.

For field testing, the Spectrace 9000 was placed on board R/V *Ecos*, a 40-foot survey craft with 200 square feet of laboratory space. XRF measurements were made on sediments collected during a survey in San Diego Bay along four transects and one survey line in areas of Navy activity.

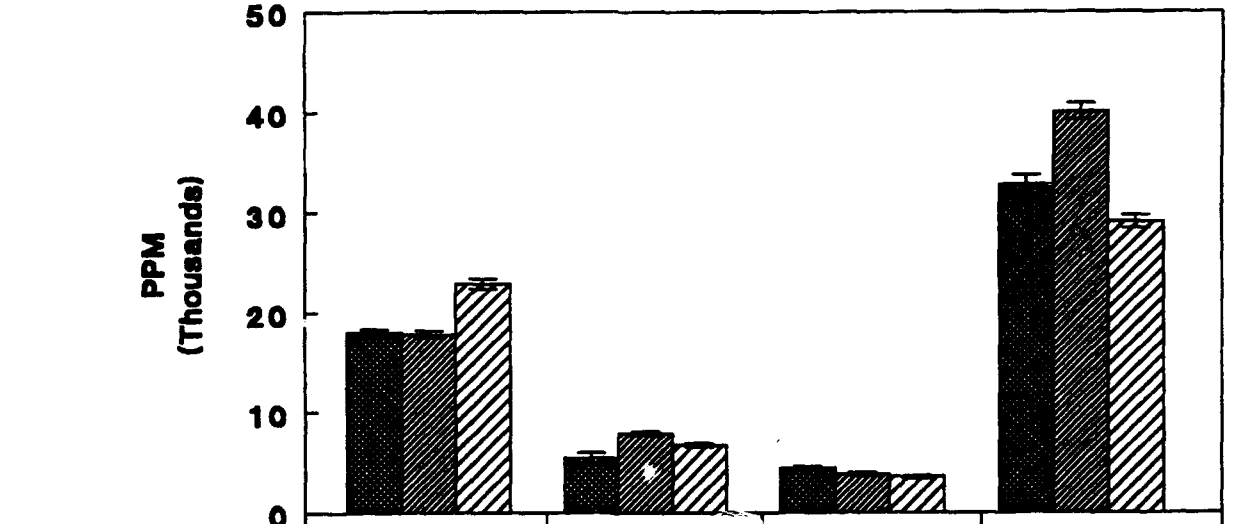
We had the following objectives: (1) to explore the variation of replicate wet samples from the same sediment grab; (2) to compare the analysis of the natural wet samples with dried, homogenized samples; and (3) to demonstrate the feasibility of obtaining very rapid metals analyses on site. Since the sediment was too wet to place the probe directly into it, samples were transferred into prepared x-ray sample cups for measurement. Data were collected on the instrument software and also, for purposes of demonstration and the safety of the data, were continuously transferred to a personal computer. We used the second of the two application programs, which was intended for field analysis.

We encountered only one minor problem. The personnel manning the sediment grabber were very efficient in their sample collection, and eventually our triplicate measurements, 220 seconds of live counting for each sample, lagged sample collection. As a result of this data lag, we were still measuring as the vessel returned home at a full speed of about 14 knots. The resulting motion intermittently caused the instrument to take repeated measurements of the same sample.



	K	Ca	Ti	Fe
CERTIFIED	12,450	20,878	4214	48,650
XRF-1	11,481	22,530	3595	53,674
XRF-2	13,140	20,202	3415	37,304

(a) PACS-1.

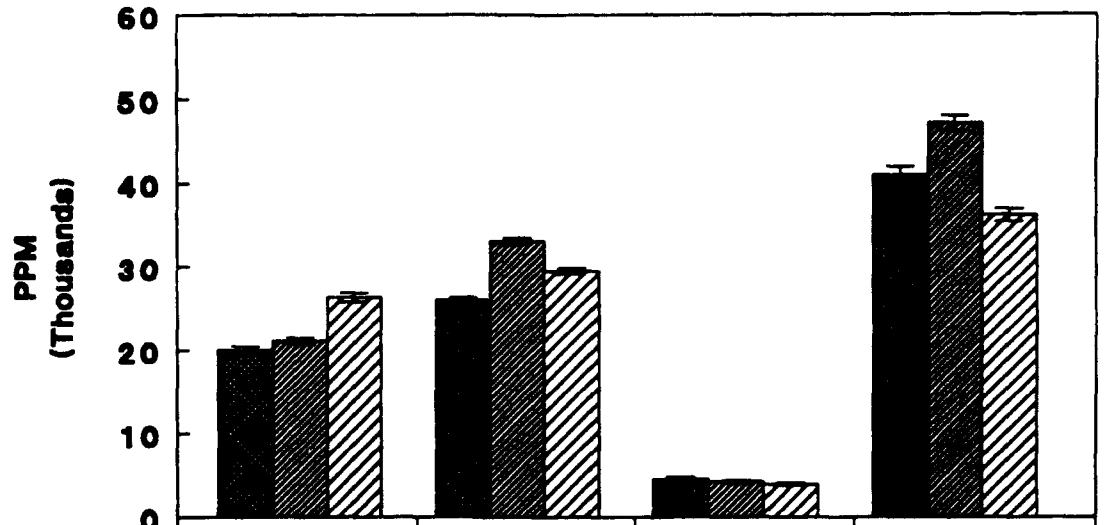


	K	Ca	Ti	Fe
CERTIFIED	18,011	5434	4400	32,853
XRF-1	17,841	7868	3798	40,107
XRF-2	22,872	6742	3545	29,108

(b) BCSS-1.

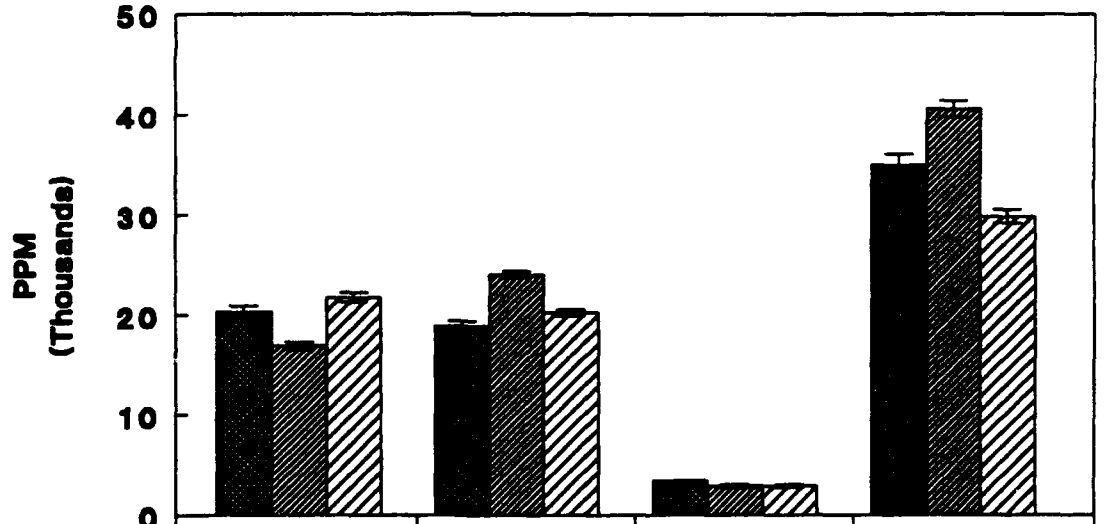
Figure 2. Major elements in certified reference materials.

(Contd)



	K	Ca	Ti	Fe
CERTIFIED	20,000	26,000	4570	41,000
XRF-1	21,082	33,108	4226	47,149
XRF-2	26,306	29,487	3892	36,197

(c) Soil 2704.

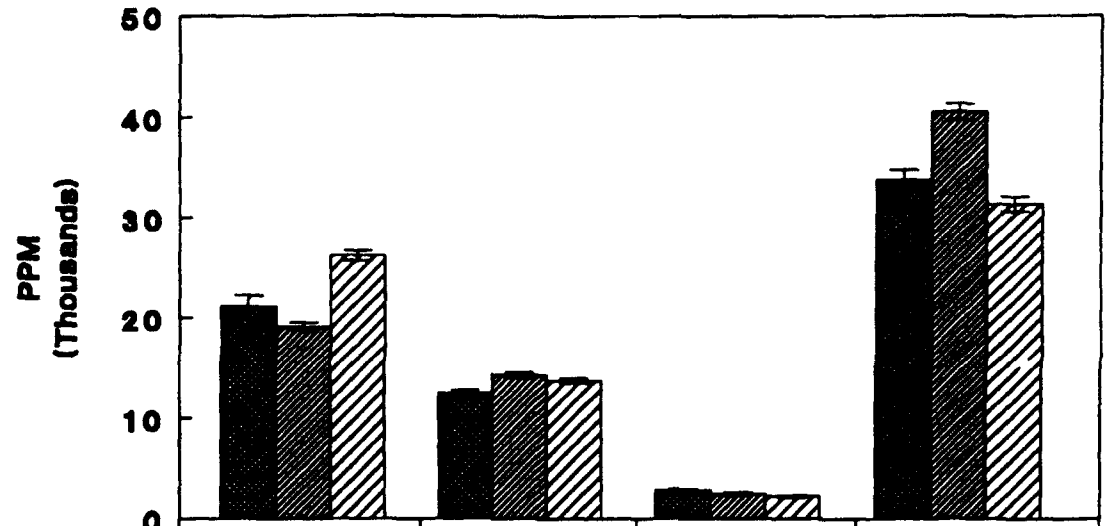


	K	Ca	Ti	Fe
CERTIFIED	20,300	18,900	3420	35,000
XRF-1	16,928	24,058	2879	40,610
XRF-2	21,736	20,233	2880	29,824

(d) Soil 2709.

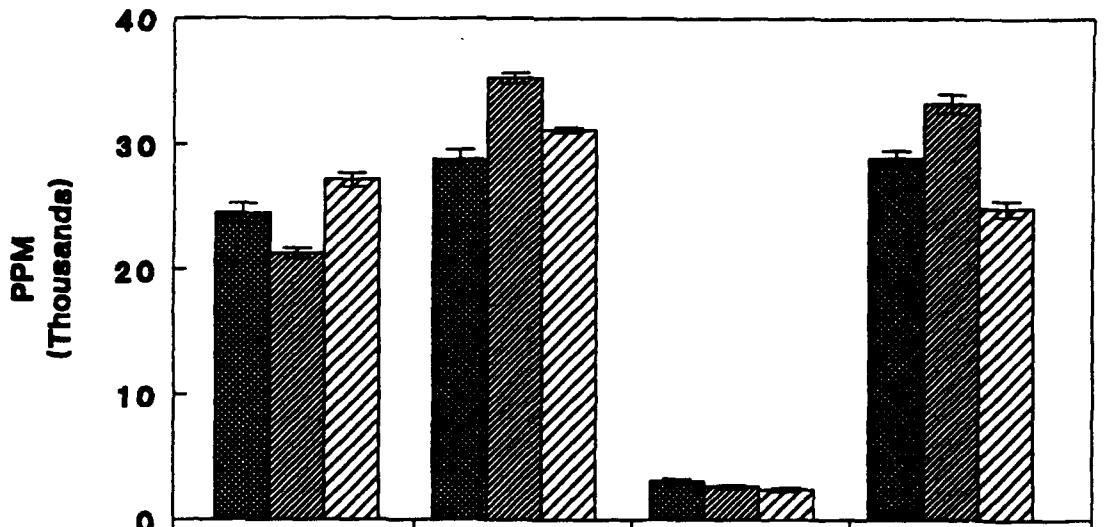
Figure 2. Continued.

(Contd)



	K	Ca	Ti	Fe
CERTIFIED	21,100	12,500	2830	33,800
XRF-1	19,045	14,309	2414	40,560
XRF-2	26,203	13,728	2201	31,369

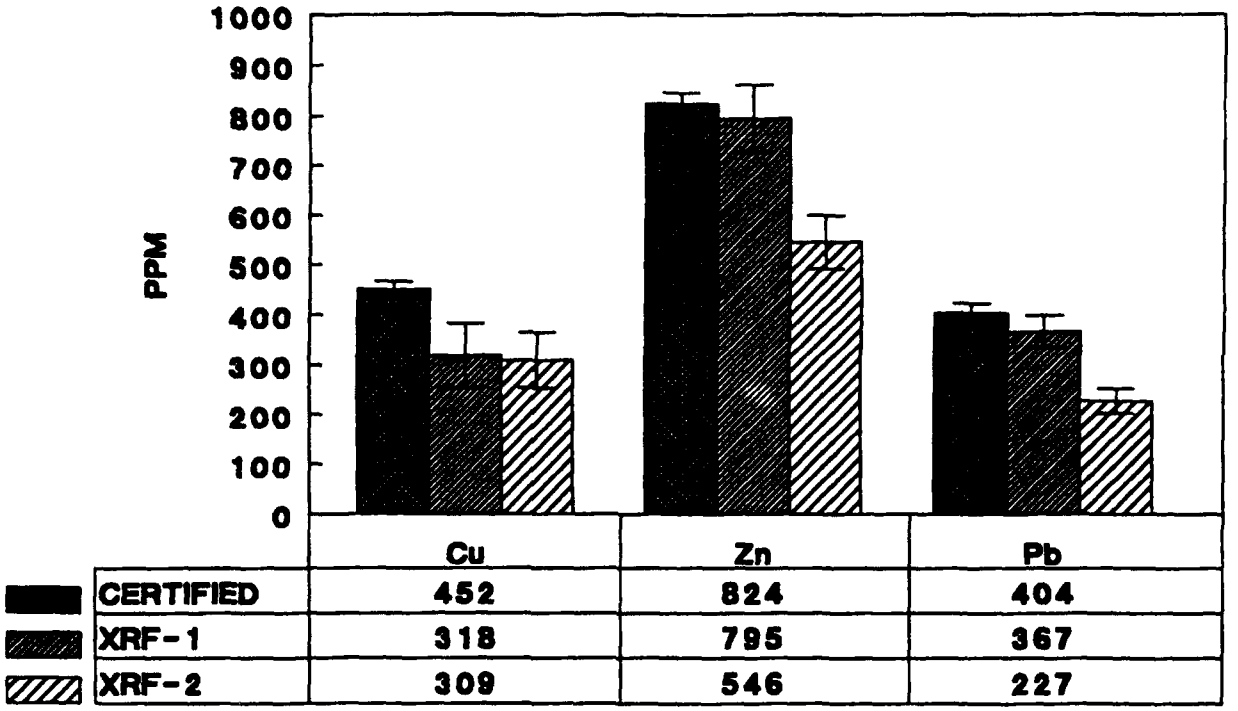
(e) Soil 2710.



	K	Ca	Ti	Fe
CERTIFIED	24,500	28,800	3060	28,900
XRF-1	21,266	35,293	2649	33,263
XRF-2	27,151	31,164	2394	24,876

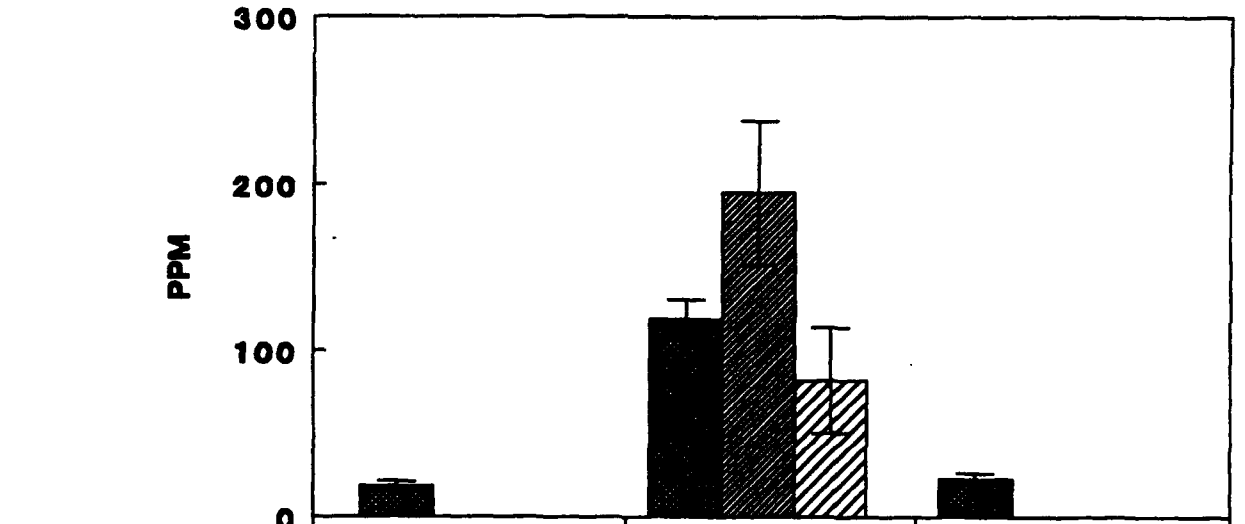
(f) Soil 2711.

Figure 2. Continued.



	Cu	Zn	Pb
CERTIFIED	452	824	404
XRF-1	318	795	367
XRF-2	309	546	227

(a) PACS-1.

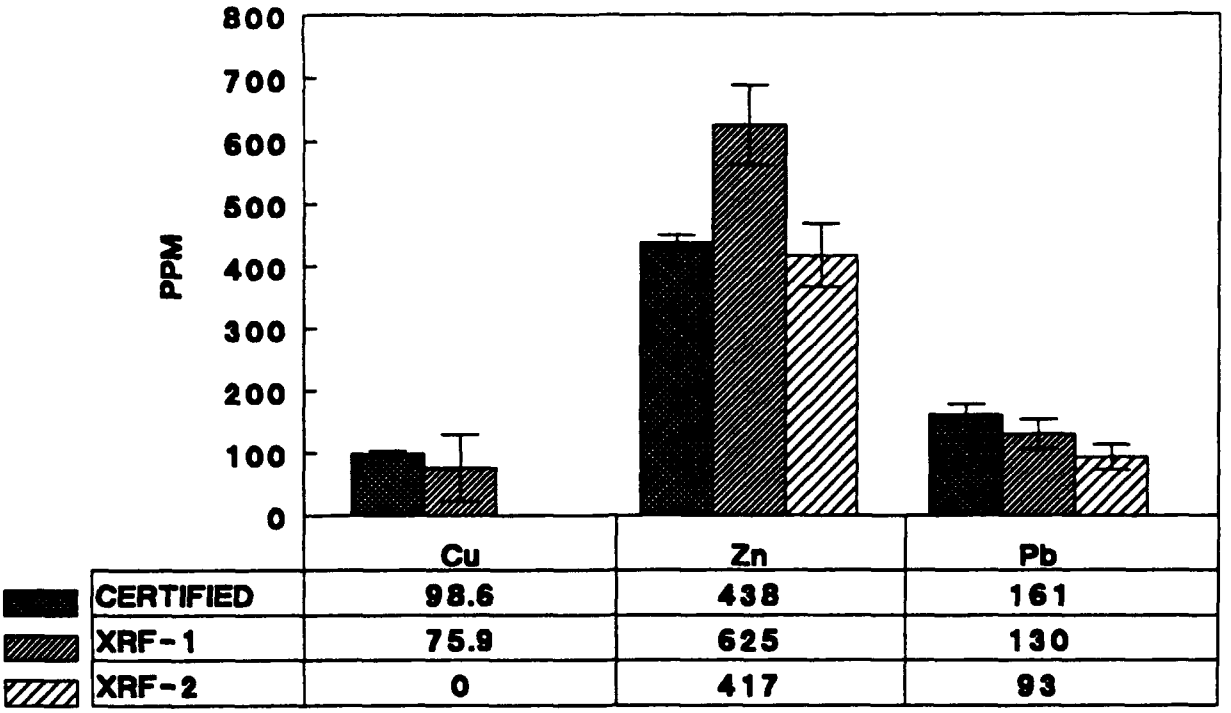


	Cu	Zn	Pb
CERTIFIED	18.5	119	22.7
XRF-1	0	195	0
XRF-2	0	82	0

(b) BCSS-1.

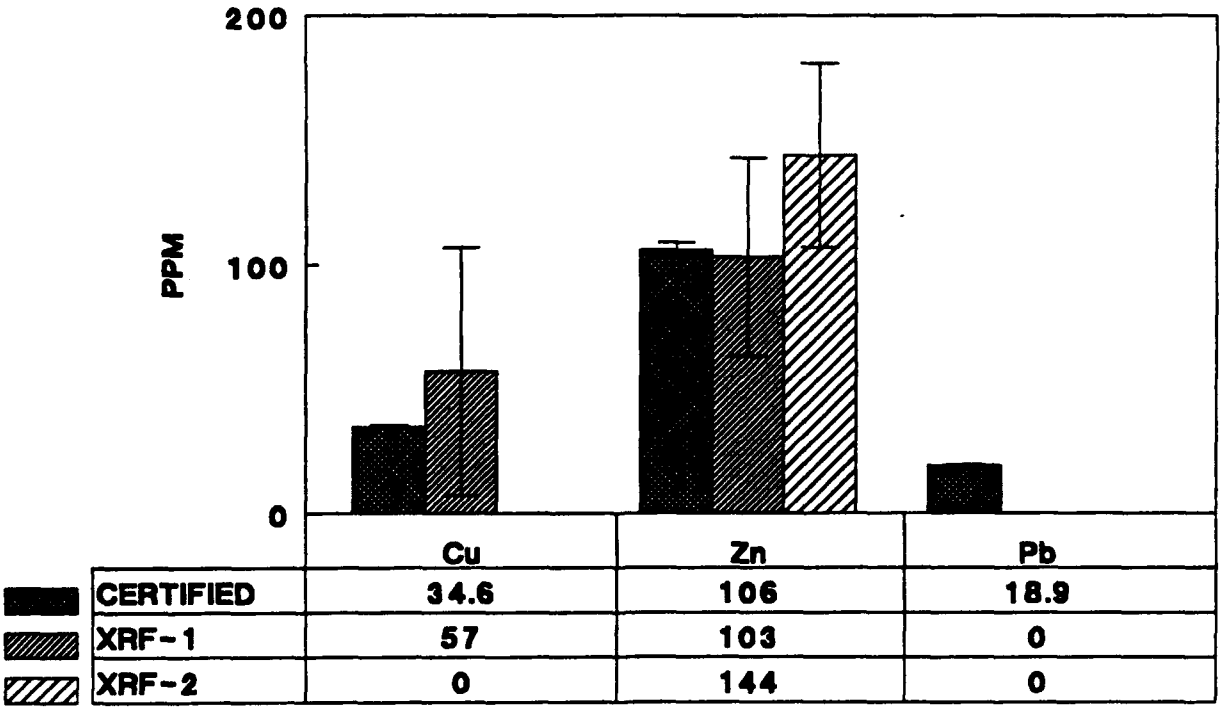
Figure 3. Trace elements in certified reference materials.

(Contd)



	Cu	Zn	Pb
CERTIFIED	98.6	438	161
XRF-1	75.9	625	130
XRF-2	0	417	93

(c) Soil 2704.

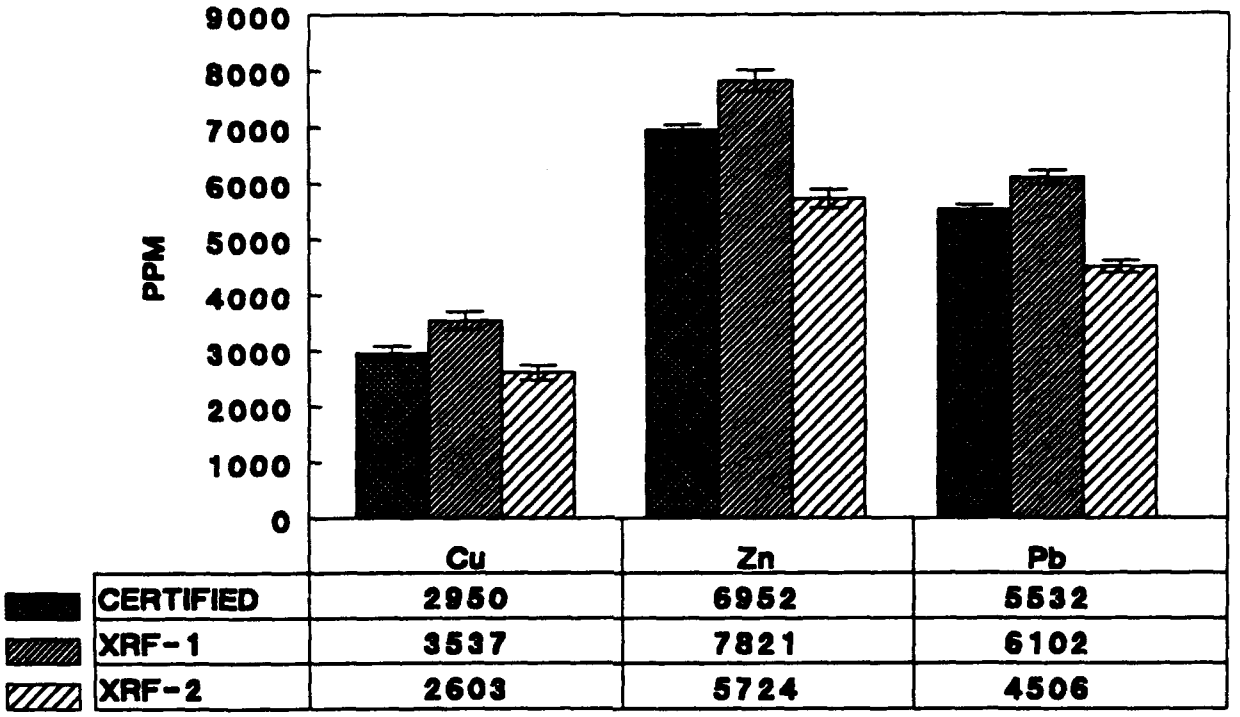


	Cu	Zn	Pb
CERTIFIED	34.6	106	18.9
XRF-1	57	103	0
XRF-2	0	144	0

(d) Soil 2709.

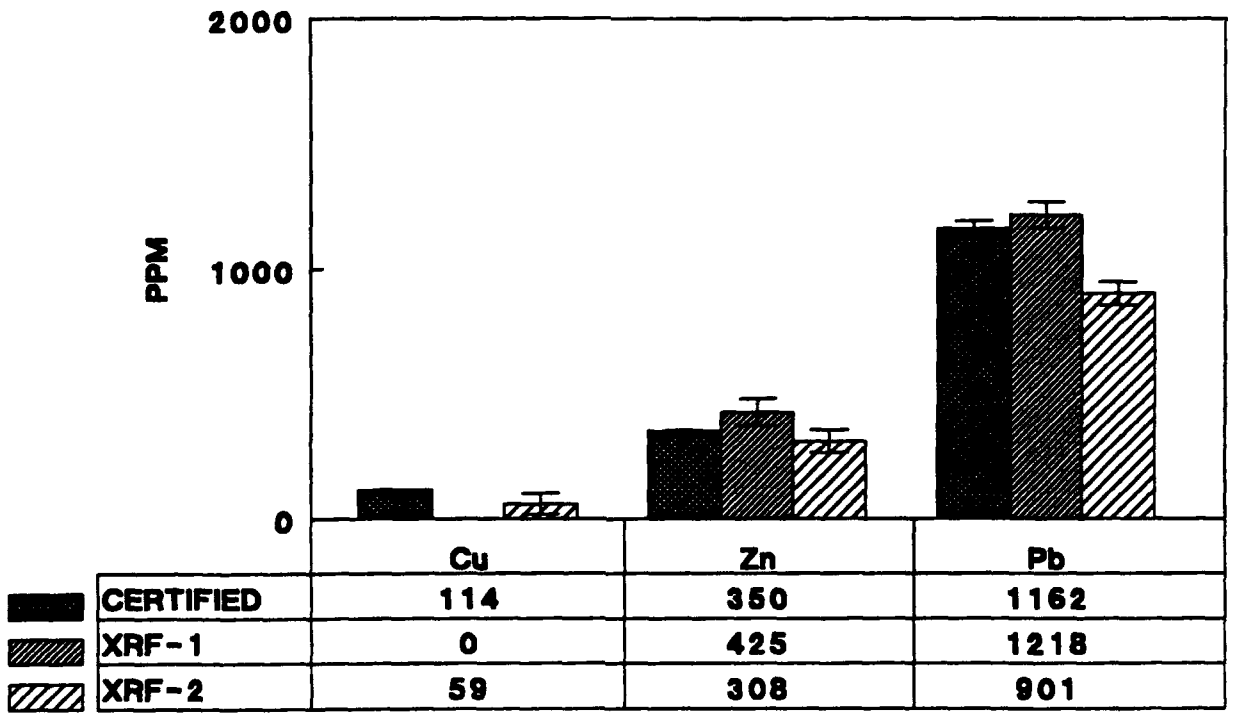
Figure 3. Continued.

(Contd)



	Cu	Zn	Pb
CERTIFIED	2950	6952	5532
XRF-1	3537	7821	6102
XRF-2	2603	5724	4506

(e) Soil 2710.



	Cu	Zn	Pb
CERTIFIED	114	350	1162
XRF-1	0	425	1218
XRF-2	59	308	901

(f) Soil 2711.

Figure 3. Continued.

The probe has an additional start button for remote (6 feet) measurements, which was apparently being activated by vibration. This indicates either that the instrument should not be operated while this vessel is going full speed or that some sort of vibration damping should be used. Later data reduction showed that triplicate measurements in the field are probably not necessary; thus, measurements could have been easily completed at survey speeds.

The complete data set can be found in Appendix A. The following elements were measured: potassium, calcium, titanium, chromium, manganese, iron, cobalt, nickel, copper, zinc, arsenic, selenium, strontium, zirconium, molybdenum, mercury, lead, rubidium, cadmium, barium, silver, uranium, thorium, antimony, and tin. The American Chemical Society (Keith et al., 1983) has defined the limit of detection (LOD) as the lowest concentration level that can be determined to be statistically different from a blank; LOD is further defined as three times the standard deviation of a series of blanks (3 σ). Ten σ is often considered the limit of quantitation (LOQ) and is the level above which quantitative results may be obtained with a specified degree of confidence. The region between 3 and 10 σ is considered to be the region of "less certain quantitation." LOD and the LOQ correspond to a relative standard deviation (RSD) of 33 and 10%, respectively. Therefore, values having an RSD of greater than 33% on a single sample (listed along the rows for each element) are best described as "not detected"; they are not zero, but merely below the sensitivity of the instrument. The RSD values for replicate samples (shown in the first column below the mean of the replicates) best describe sample heterogeneity at the site. In addition, owing to the large quantity of data that had to be stored, full XRF spectra could not be obtained for each sample. Element identification was assigned by instrument software. We did not have the chance to examine the spectra to determine whether a correct identification had been made or whether interferences may have caused an incorrect element assignment.

There was no difference in data quality, expressed as RSD of either the instrumental performance or replicates, between wet samples analyzed at sea or analyzed in the laboratory. Table 1 shows representative data for four of the 25 elements analyzed. Transect D was selected for illustration purposes because we had determined its water content in the laboratory; to limit the physical size of the table, data are truncated to four stations only. We chose potassium (1–2% abundance), titanium (0.2–0.4% abundance), barium (0.02% abundance), and lead (0.001% abundance) to demonstrate the typical performance of the portable XRF spectrometer over a range of concentrations. The XRF detection limit (DET LMT) for a 200-second count time for each source, concentration in ppm, and the RSD of the measurement, i.e., the counting statistics, for each separate sample analysis are shown for each element. The concentrations of the elements for each station in both wet and dried samples, the RSD of the measurement, and the mean element concentrations of the replicates and their RSD, are also shown. The relative standard deviation is the standard deviation divided by the mean, multiplied by 100, to express the value as percent.

In both wet and dry samples, the RSD between replicate samples, shown in the column below the mean, was very close to the RSD of each measurement, shown in the row to the right of the concentration, for potassium, titanium, and barium. More variation was found for lead because of the lower concentrations, and because the lead is anthropogenic and heterogeneously distributed. The water content of the samples varied from approximately 30 to 60%. Variations in elemental concentrations between wet and dry samples did not correlate with the water

Table 1. XRF analysis of selected elements in wet and dry samples.

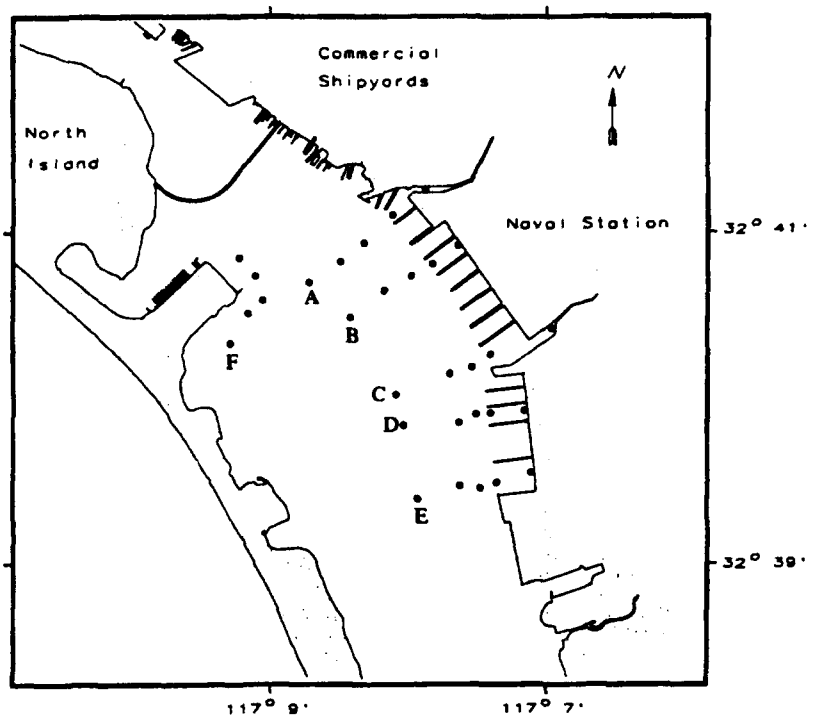
Station and Parameters	K, ppm	K, RSD	Ti, ppm	Ti, RSD	Ba, ppm	Ba, RSD	Pb, ppm	Pb, RSD
DET LMT	161		55		9		14	
STATION								
D11W	11073	6	2631	8	175	5	59	24
D12W	9782	6	2046	11	142	5	18	67
D13W	11721	6	2574	9	141	5	36	33
MEAN D1	10859		2417		153		38	
RSD	7		11		10		45	
D11D	21709	4	3996	7	257	4	32	34
D12D	22900	4	4588	6	223	4	16	75
D13D	23377	4	4886	6	286	3	25	52
MEAN D1	22662		4490		255		24	
RSD	3		8		10		27	
D21W	15555	5	3011	8	170	5	19	63
D22W	16798	4	3135	8	184	4	27	48
D23W	15405	5	3345	7	183	4	0	N/A
MEAN D2	15919		3164		179		15	
RSD	4		4		4		74	
D21D	22011	4	4633	6	208	4	27	44
D22D	22842	4	4134	7	219	4	0	N/A
D23D	22089	4	4233	7	183	4	13	85
MEAN D2	22314		4333		203		13	
RSD	2		5		7		83	
D31W	16784	5	3544	7	266	3	0	N/A
D32W	17046	4	3394	7	235	4	18	67
D33W	14409	5	2577	9	243	4	20	60
MEAN D3	16080		3172		248		13	
RSD	7		13		5		71	
D31D	21658	1	3471	8	248	4	28	46
D32D	21922	4	4757	6	270	3	40	33
D33D	21359	4	4254	6	276	3	0	N/A
MEAN D3	21646		4161		265		23	
RSD	1		13		5		74	
D41W	11592	6	2232	9	331	3	0	N/A
D42W	11132	6	2531	8	342	3	33	36
D43W	12181	5	284	75	338	3	0	N/A
MEAN D4	11635		1682		337		11	
RSD	4		59		1		141	
D41D	17299	5	2897	8	363	3	16	69
D42D	16439	5	2503	9	305	3	0	N/A
D43D	18166	4	3124	7	272	3	12	83
MEAN D4	17301		2841		313		9	
RSD	4		9		12		73	

content. Wet-to-dry-element concentration ratios were approximately 0.5 for the lighter major elements, but approximately 1.0 for the heavier trace elements. There was more variation of concentration in trace metals in replicate wet samples than in replicate dry samples, because the latter were well ground and mixed after drying.

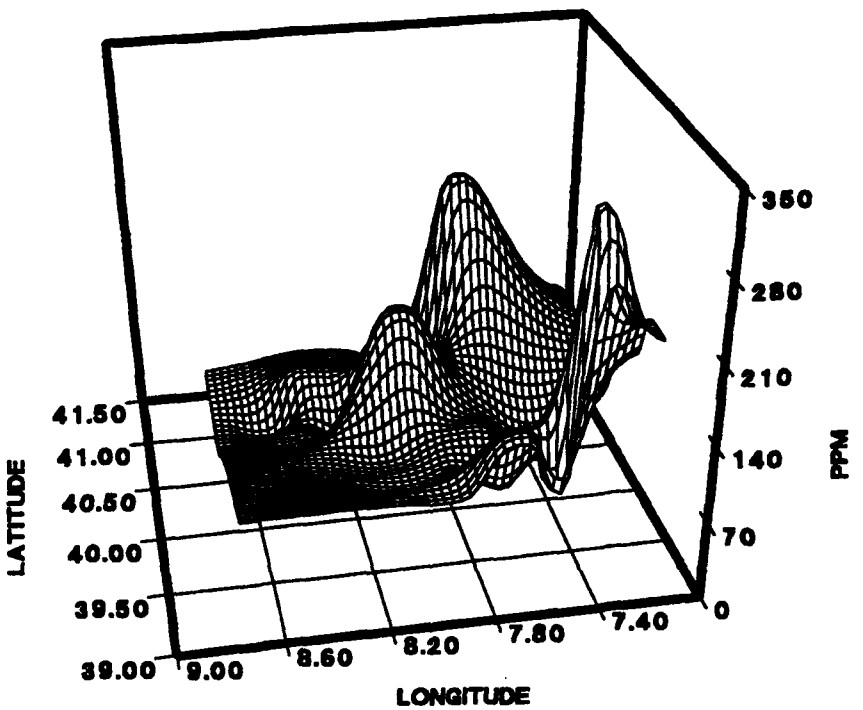
Based on the discussion above concerning the reliability of the data, the values for potassium, titanium, and barium are well above the LOQ; values for lead are mostly uncertain both for counting statistics of the individual samples and in variation among subsample measurements. The reliability of the lead data could be improved by increasing the count time of the Cd-109 source to 200 seconds. Recently, Raab et al. (1991) were strongly in favor of the use of field-portable XRF spectrometers. A single site screening will pay for the costly instrument, provide immediate on-site results for many measurements, and restrict necessary physical sampling to those areas where the field values are below 10 σ. Raab and his coauthors also emphasize that the portable XRF spectrometer is a valuable screening tool. These authors found that inductively coupled plasma atomic emission spectrophotometry (ICP) analyses yield metal concentrations lower than those produced by XRF measurements; they attribute this result to the fact that the sediment digestions performed by strict contract laboratory program (CLP) protocol are incomplete. We also found that ICP results, obtained by an outside CLP laboratory, were lower than XRF results for many elements; however, good agreement was found for copper, zinc, and lead.

Figure 4a is a map of San Diego Bay with transects A through E and cruise track F. Transects A through E were conducted in San Diego Bay off the San Diego Naval Station. Transect A started 100 yards into Chollas Creek, which is the demarcation between commercial piers and the Navy facility. A San Diego industrial area, with many private shipyards, is to the north of transect A. Transect B started between Piers 3 and 4. Transect C started at Polleta Creek between Pier 8 and the Mole Pier. Transect D started between Piers 11 and 12. Transect E started in the Turning Basin near Pier 14. The five stations for transects A through E were each sampled at the following locations: (1) near the quay wall, (2) at the end of the piers, (3) in the middle of the channel, (4) at the edge of the channel, and (5) in the middle of the bay. Cruise track F was conducted around the Naval Amphibious Base, where stations 1 through 5 were randomly selected as shown.

We selected copper, zinc, and lead, as measured by XRF spectrometry in wet sediments, to construct sediment concentration maps for the area of San Diego Bay that we studied; these are shown in figures 4b, 4c, and 4d, respectively. These metals consistently appeared in the samples significantly above the XRF detection limits; and the relative standard deviations between replicates indicated that we were not looking at an isolated, spurious occurrence of the metal. The X and Y axes of the plots are decimal degree minutes of latitude 32 and longitude 117, respectively. These contour maps are oriented with respect to San Diego Bay. The quay wall of transect A lies at the hidden corner of the contour map; the quay wall of transect E lies to the top right. Copper, zinc, and lead concentrations are highest at Chollas Creek near the shore and decrease toward the center of the channel and beyond. The noticeable decrease in concentration at the end of the piers may simply indicate perturbations owing to current flow around the piers or be related to grain size distributions, caused by currents around the piers. Current flow and land runoff may cause differential transport of sediment fractions. Anthropogenic heavy metals are known to adsorb predominantly on the fine clay and silt fractions of sediment (Ackermann, 1980). Copper concentration is again elevated at transect E, just south of which a copper ore spill occurred at Paco terminal some years ago; this area is currently being dredged.



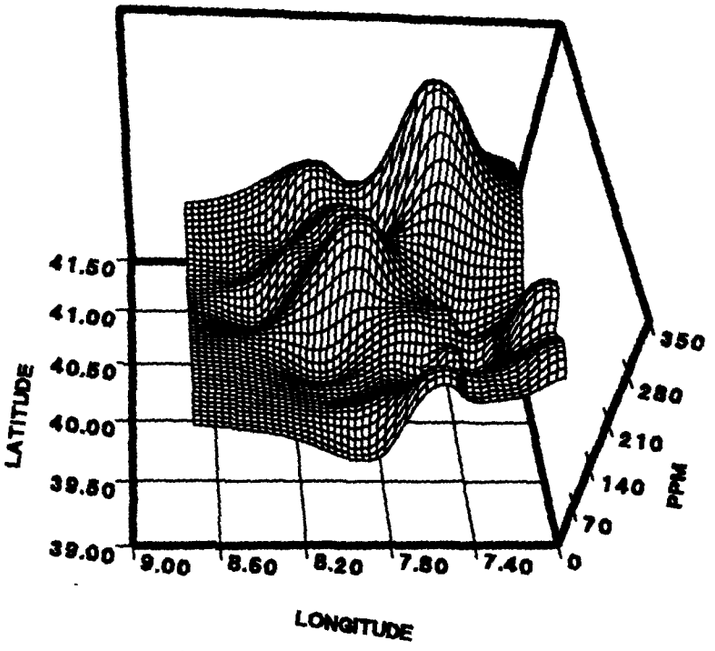
(a) Transects and stations in San Diego Bay.



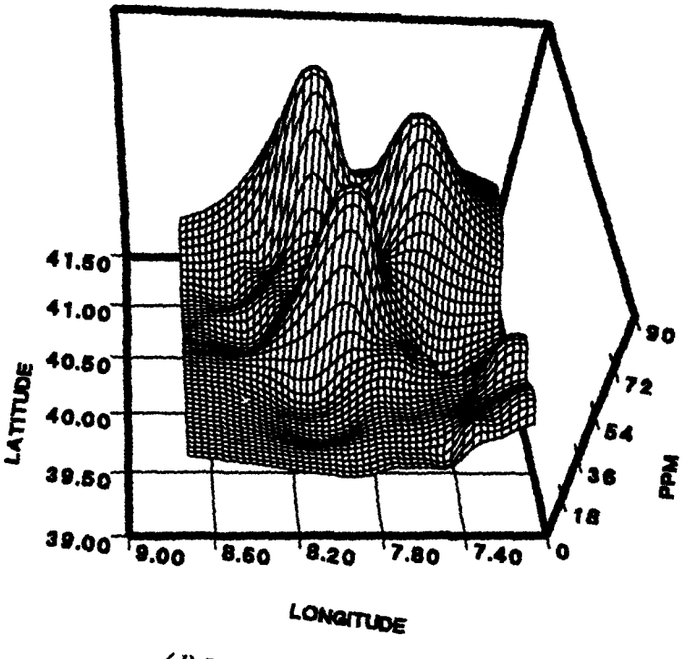
(b) Copper in wet sediment.

Figure 4. Transects, stations, and sediment concentrations in San Diego Bay.

(Contd)



(c) Zinc in wet sediment.



(d) Lead in wet sediment.

Figure 4. Continued.

CONCLUSIONS

XRF spectrometry provides precise and rapid measurements at detection levels relevant to concentrations indicative of pollution for a wide range of metals. A field-portable XRF spectrometer can perform well on board survey vessels and generate data from sediment grabs in a time frame that could guide on-site decision-making for mapping strategies and detailed sampling.

We demonstrated selected trace metals in San Diego Bay as a mapping application of XRF spectrometry. Areas can quickly be reinvestigated if necessary. Since XRF spectrometry is a nondestructive technique, additional or confirmatory analysis of the same sample by an analytical laboratory is possible.

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Appendix A

FIELD ANALYSIS DATA

XRF FIELD TEST---SEA TRIALS---JULY 1, 1993

STATION (Sample)	Cr ppm	Cr Std Dev	Cr RSD	K ppm	K Std Dev	K RSD	Ca ppm	Ca Std Dev	Ca RSD
A11W	0	0	N/A	11133	639	6	11375	410	4
A12W	235	207	88	10852	633	6	11670	415	4
A13W	0	0	N/A	11129	640	6	11887	418	4
MEAN A1	78			11038			11644		
STD DEV	111			132			210		
RSD	141			1			2		
A21W	0	0	N/A	13013	677	5	7893	356	5
A22W	0	0	N/A	12877	672	5	6933	337	5
A23W	0	0	N/A	14020	699	5	7991	360	5
MEAN A2	0			13303			7606		
STD DEV	0			510			477		
RSD	N/A			4			6		
A31W	0	0	N/A	10105	614	6	10562	396	4
A32W	0	0	N/A	11364	644	6	11375	411	4
A33W	0	0	N/A	10906	633	6	10696	399	4
MEAN A3	0			10792			10878		
STD DEV	0			520			356		
RSD	N/A			5			3		
A41W	246	204	83	10996	639	6	13983	449	3
A42W	0	0	N/A	11816	659	6	14992	464	3
A43W	0	0	N/A	11139	643	6	14328	454	3
MEAN A4	82			11317			14434		
STD DEV	116			358			419		
RSD	141			3			3		
A51W	0	0	N/A	9498	603	6	13795	443	3
A52W	0	0	N/A	9918	613	6	13164	435	3
A53W	0	0	N/A	10759	635	6	15021	463	3
MEAN A5	0			10058			13993		
STD DEV	0			524			771		
RSD	N/A			5			6		

XRF FIELD TEST—SEA TRIALS—JULY 1, 1993

STATION (Sample)	Cr ppm	Cr Std Dev	Cr RSD	K ppm	K Std Dev	K RSD	Ca ppm	Ca Std Dev	Ca RSD
B11W	0	0	N/A	12238	659	5	7107	340	5
B12W	0	0	N/A	12461	663	5	6585	330	5
B13W	0	0	N/A	10834	627	6	7059	336	5
MEAN B1	0			11844			6917		
STD DEV	0			720			236		
RSD	N/A			6			3		
B21W	0	0	N/A	11942	655	5	8850	371	4
B22W	0	0	N/A	11743	653	6	10843	403	4
B23W	0	0	N/A	13318	686	5	10160	395	4
MEAN B2	0			12334			9951		
STD DEV	0			700			827		
RSD	N/A			6			8		
B31W	0	0	N/A	12676	670	5	8404	364	4
B32W	0	0	N/A	13189	681	5	8053	359	4
B33W	0	0	N/A	11770	650	6	7931	354	4
MEAN B3	0			12545			8129		
STD DEV	0			587			201		
RSD	N/A			5			2		
B41W	0	0	N/A	11377	644	6	11009	405	4
B42W	0	0	N/A	12370	667	5	11907	421	4
B43W	0	0	N/A	12614	672	5	11107	409	4
MEAN B4	0			12120			11341		
STD DEV	0			535			402		
RSD	N/A			4			4		
B51W	0	0	N/A	9353	598	6	11975	416	3
B52W	0	0	N/A	10707	631	6	13292	438	3
B53W	0	0	N/A	9592	604	6	12360	422	3
MEAN B5	0			9884			12542		
STD DEV	0			590			553		
RSD	N/A			6			4		

XRF FIELD TEST—SEA TRIALS—JULY 1, 1993

STATION (Sample)	Cr ppm	Cr Std Dev	Cr RSD	K ppm	K Std Dev	K RSD	Ca ppm	Ca Std Dev	Ca RSD
C11W	0	0	N/A	12275	662	5	9263	378	4
C12W	0	0	N/A	13383	688	5	10238	397	4
C13W	0	0	N/A	12094	659	5	9486	382	4
MEAN C1	0			12584			9662		
STD DEV	0			570			417		
RSD	N/A			5			4		
C21W	0	0	N/A	11390	676	6	36359	697	2
C22W	0	0	N/A	11842	690	6	40815	737	2
C23W	0	0	N/A	11673	683	6	37765	710	2
MEAN C2	0			11635			38313		
STD DEV	0			186			1860		
RSD	N/A			2			5		
C31W	0	0	N/A	14948	719	5	8883	377	4
C32W	0	0	N/A	12791	674	5	9789	388	4
C33W	0	0	N/A	13165	682	5	9601	386	4
MEAN C3	0			13635			9424		
STD DEV	0			941			390		
RSD	N/A			7			4		
C41W	0	0	N/A	12296	663	5	9042	375	4
C42W	0	0	N/A	12723	670	5	7845	355	5
C43W	0	0	N/A	13278	683	5	8021	359	4
MEAN C4	0			12766			8303		
STD DEV	0			402			528		
RSD	N/A			3			6		
C51W	249	200	80	10173	615	6	10170	389	4
C52W	0	0	N/A	11707	651	6	11225	409	4
C53W	220	200	91	12377	664	5	9228	378	4
MEAN C5	156			11419			10208		
STD DEV	111			923			816		
RSD	71			8			8		

STATION (Sample)	Tl ppm	Tl Std Dev	Tl RSD	Mn ppm	Mn Std Dev	Mn RSD	Fe ppm	Fe Std Dev	Fe RSD
A11W	2068	209	10	770	203	26	22037	446	2
A12W	2622	218	8	511	195	38	22808	455	2
A13W	1936	221	11	429	191	45	23066	457	2
MEAN A1	2209			570			22637		
STD DEV	297			145			437		
RSD	13			25			2		
A21W	2763	232	8	532	201	38	31164	534	2
A22W	2437	228	9	498	196	39	29394	517	2
A23W	2564	231	9	638	204	32	29411	518	2
MEAN A2	2588			556			29990		
STD DEV	134			60			830		
RSD	5			11			3		
A31W	2022	202	10	524	188	36	23150	455	2
A32W	1784	210	12	467	186	40	22451	450	2
A33W	2542	215	8	479	186	39	23948	465	2
MEAN A3	2116			490			23183		
STD DEV	317			25			612		
RSD	15			5			3		
A41W	2134	212	10	503	192	38	21082	438	2
A42W	2345	207	9	696	200	29	21482	443	2
A43W	2075	210	10	894	207	23	21240	440	2
MEAN A4	2185			698			21268		
STD DEV	116			160			164		
RSD	5			23			1		
A51W	1796	187	10	619	191	31	17577	398	2
A52W	1715	187	11	655	190	29	17986	402	2
A53W	1815	196	11	345	174	50	18045	404	2
MEAN A5	1775			540			17869		
STD DEV	43			138			208		
RSD	2			26			1		

STATION (Sample)	Tl ppm	Tl Std Dev	Tl RSD	Mn ppm	Mn Std Dev	Mn RSD	Fe ppm	Fe Std Dev	Fe RSD
B11W	1848	214	12	396	194	49	33168	548	2
B12W	2059	214	10	501	196	39	33264	549	2
B13W	2190	219	10	688	204	30	31542	533	2
MEAN B1	2032			528			32658		
STD DEV	141			121			790		
RSD	7			23			2		
B21W	2094	219	10	434	191	44	28715	510	2
B22W	2504	220	9	664	199	30	27710	502	2
B23W	2582	226	9	620	200	32	28247	508	2
MEAN B2	2393			573			28224		
STD DEV	214			100			411		
RSD	9			17			1		
B31W	2899	224	8	417	193	46	31665	538	2
B32W	2278	218	10	695	203	29	31428	535	2
B33W	2625	223	8	592	200	34	31368	533	2
MEAN B3	2601			568			31487		
STD DEV	254			115			128		
RSD	10			20			0		
B41W	2361	223	9	542	195	36	26128	487	2
B42W	2400	221	9	411	192	47	26488	492	2
B43W	3103	229	7	447	191	43	27606	502	2
MEAN B4	2621			467			26741		
STD DEV	341			55			629		
RSD	13			12			.2		
B51W	1799	190	11	768	191	25	18250	404	2
B52W	1638	185	11	767	196	26	19573	420	2
B53W	1539	188	12	612	189	31	19017	413	2
MEAN B5	1659			716			18947		
STD DEV	107			73			542		
RSD	6			10			3		

STATION (Sample)	Tl ppm	Tl Std Dev	Tl RSD	Mn ppm	Mn Std Dev	Mn RSD	Fe ppm	Fe Std Dev	Fe RSD
C11W	2548	220	9	575	200	35	30424	526	2
C12W	2588	224	9	468	197	42	30492	529	2
C13W	2407	214	9	954	212	22	29352	516	2
MEAN C1	2514			666			30089		
STD DEV	78			209			522		
RSD	3			31			2		
C21W	2577	233	9	1230	229	19	27270	512	2
C22W	2081	235	11	1074	224	21	27850	520	2
C23W	2229	226	10	1342	237	18	27347	515	2
MEAN C2	2296			1215			27489		
STD DEV	208			110			257		
RSD	9			9			1		
C31W	2717	235	9	561	202	36	33478	556	2
C32W	3299	232	7	765	213	28	36059	577	2
C33W	2590	229	9	642	201	31	33608	555	2
MEAN C3	2869			656			34382		
STD DEV	309			84			1187		
RSD	11			13			3		
C41W	2520	231	9	939	216	23	33445	553	2
C42W	1243	226	18	2966	283	10	25888	485	2
C43W	1425	231	16	2460	269	11	25971	487	2
MEAN C4	1729			2122			28435		
STD DEV	564			861			3543		
RSD	33			41			12		
C51W	990	196	20	955	205	21	15750	376	2
C52W	1112	200	18	2448	258	11	13720	354	3
C53W	573	208	36	2333	255	11	13834	355	3
MEAN C5	892			1912			14435		
STD DEV	231			678			931		
RSD	26			35			6		

STATION (Sample)	Co ppm	Co Std Dev	Co RSD	Ni ppm	Ni Std Dev	Ni RSD	Cu ppm	Cu Std Dev	Cu RSD
A11W	0	0	N/A	0	0	N/A	0	0	N/A
A12W	0	0	N/A	0	0	N/A	0	0	N/A
A13W	365	161	44	76	55	73	0	0	N/A
MEAN A1	122			25			0		
STD DEV	172			36			0		
RSD	141			141			N/A		
A21W	0	0	N/A	0	0	N/A	128	38	29
A22W	498	180	36	0	0	N/A	0	0	N/A
A23W	0	0	N/A	0	0	N/A	67	35	52
MEAN A2	166			0			65		
STD DEV	235			0			52		
RSD	141			N/A			81		
A31W	0	0	N/A	0	0	N/A	33	31	96
A32W	245	157	64	0	0	N/A	102	35	34
A33W	0	0	N/A	0	0	N/A	70	33	48
MEAN A3	82			0			68		
STD DEV	115			0			28		
RSD	141			N/A			41		
A41W	247	153	62	0	0	N/A	0	0	N/A
A42W	0	0	N/A	0	0	N/A	34	31	91
A43W	0	0	N/A	0	0	N/A	0	0	N/A
MEAN A4	82			0			11		
STD DEV	116			0			16		
RSD	141			N/A			141		
A51W	192	141	73	0	0	N/A	0	0	N/A
A52W	0	0	N/A	0	0	N/A	0	0	N/A
A53W	0	0	N/A	0	0	N/A	58	31	54
MEAN A5	64			0			19		
STD DEV	91			0			27		
RSD	141			N/A			141		

STATION (Sample)	Co ppm	Co Std Dev	Co RSD	Ni ppm	Ni Std Dev	Ni RSD	Cu ppm	Cu Std Dev	Cu RSD
B11W	0	0	N/A	0	0	N/A	259	44	17
B12W	0	0	N/A	0	0	N/A	273	44	16
B13W	0	0	N/A	0	0	N/A	208	42	20
MEAN B1	0			0			247		
STD DEV	0			0			28		
RSD	N/A			N/A			11		
B21W	0	0	N/A	0	0	N/A	60	33	55
B22W	0	0	N/A	0	0	N/A	38	32	84
B23W	0	0	N/A	79	57	71	98	36	36
MEAN B2	0			26			65		
STD DEV	0			37			25		
RSD	N/A			141			38		
B31W	0	0	N/A	61	58	95	101	37	36
B32W	0	0	N/A	0	0	N/A	79	36	45
B33W	254	180	71	60	59	98	161	39	24
MEAN B3	85			40			114		
STD DEV	120			28			34		
RSD	141			71			30		
B41W	0	0	N/A	0	0	N/A	48	33	68
B42W	0	0	N/A	110	57	52	0	0	N/A
B43W	0	0	N/A	0	0	N/A	0	0	N/A
MEAN B4	0			37			16		
STD DEV	0			52			23		
RSD	N/A			141			141		
B51W	0	0	N/A	0	0	N/A	0	0	N/A
B52W	0	0	N/A	110	57	52	60	32	53
B53W	0	0	N/A	63	51	81	48	31	65
MEAN B5	0			58			36		
STD DEV	0			45			26		
RSD	N/A			78			72		

STATION (Sample)	Co ppm	Co Std Dev	Co RSD	Ni ppm	Ni Std Dev	Ni RSD	Cu ppm	Cu Std Dev	Cu RSD
C11W	0	0	N/A	0	0	N/A	134	37	28
C12W	0	0	N/A	116	60	52	215	41	19
C13W	308	176	57	0	0	N/A	150	38	25
MEAN C1	103			39			166		
STD DEV	145			55			35		
RSD	141			141			21		
C21W	0	0	N/A	0	0	N/A	53	33	62
C22W	0	0	N/A	76	57	75	0	0	N/A
C23W	0	0	N/A	0	0	N/A	0	0	N/A
MEAN C2	0			25			18		
STD DEV	0			36			25		
RSD	N/A			141			141		
C31W	310	187	60	62	59	95	38	33	87
C32W	244	192	79	0	0	N/A	0	0	N/A
C33W	331	187	56	0	0	N/A	122	37	30
MEAN C3	295			21			53		
STD DEV	37			29			51		
RSD	13			141			96		
C41W	604	187	31	0	0	N/A	80	36	45
C42W	1074	185	17	273	68	25	75	35	47
C43W	1072	185	17	361	72	20	55	34	62
MEAN C4	917			211			70		
STD DEV	221			154			11		
RSD	24			73			15		
C51W	810	150	19	150	57	38	52	31	60
C52W	1220	156	13	0	0	N/A	52	31	60
C53W	1021	151	15	179	58	32	35	30	86
MEAN C5	1017			110			46		
STD DEV	167			78			8		
RSD	16			72			17		

STATION (Sample)	Zn ppm	Zn Std Dev	Zn RSD	As ppm	As Std Dev	As RSD	Se ppm	Se Std Dev	Se RSD
A11W	107	30	28	0	0	N/A	18	11	63
A12W	200	33	17	22	20	90	0	0	N/A
A13W	198	33	17	20	20	97	0	0	N/A
MEAN A1	168			14			6		
STD DEV	43			10			8		
RSD	26			71			141		
A21W	220	36	16	0	0	N/A	0	0	N/A
A22W	220	35	16	0	0	N/A	0	0	N/A
A23W	193	35	18	0	0	N/A	0	0	N/A
MEAN A2	211			0			0		
STD DEV	13			0			0		
RSD	6			N/A			N/A		
A31W	97	30	31	0	0	N/A	0	0	N/A
A32W	131	32	24	0	0	N/A	19	11	61
A33W	115	31	27	30	19	64	19	12	61
MEAN A3	115			10			12		
STD DEV	14			14			9		
RSD	12			141			71		
A41W	146	31	21	0	0	N/A	16	11	70
A42W	63	28	45	38	18	46	16	11	67
A43W	59	28	48	31	18	57	19	11	60
MEAN A4	89			23			17		
STD DEV	40			17			1		
RSD	45			72			7		
A51W	88	28	32	0	0	N/A	0	0	N/A
A52W	75	28	37	32	17	52	0	0	N/A
A53W	109	29	27	0	0	N/A	0	0	N/A
MEAN A5	90			11			0		
STD DEV	14			15			0		
RSD	15			141			N/A		

STATION (Sample)	Zn ppm	Zn Std Dev	Zn RSD	As ppm	As Std Dev	As RSD	Se ppm	Se Std Dev	Se RSD
B11W	446	44	10	0	0	N/A	0	0	N/A
B12W	336	41	12	0	0	N/A	0	0	N/A
B13W	258	38	15	33	22	66	0	0	N/A
MEAN B1	347			11			0		
STD DEV	77			16			0		
RSD	22			141			N/A		
B21W	153	32	21	0	0	N/A	0	0	N/A
B22W	141	32	23	0	0	N/A	13	11	85
B23W	160	33	21	30	20	67	0	0	N/A
MEAN B2	151			10			4		
STD DEV	8			14			6		
RSD	5			141			141		
B31W	208	36	17	0	0	N/A	21	12	60
B32W	209	36	17	45	20	45	0	0	N/A
B33W	207	36	17	22	20	94	0	0	N/A
MEAN B3	208			22			7		
STD DEV	1			18			10		
RSD	0			83			141		
B41W	211	34	16	0	0	N/A	0	0	N/A
B42W	155	33	21	44	20	45	20	12	59
B43W	122	31	25	41	19	46	0	0	N/A
MEAN B4	163			28			7		
STD DEV	37			20			9		
RSD	23			71			141		
B51W	46	27	59	0	0	N/A	0	0	N/A
B52W	106	30	28	52	18	35	23	11	48
B53W	68	28	41	0	0	N/A	0	0	N/A
MEAN B5	73			17			8		
STD DEV	25			25			11		
RSD	34			141			141		

STATION (Sample)	Zn ppm	Zn Std Dev	Zn RSD	As ppm	As Std Dev	As RSD	Se ppm	Se Std Dev	Se RSD
C11W	257	36	14	0	0	N/A	20	12	60
C12W	256	38	15	0	0	N/A	0	0	N/A
C13W	216	35	16	0	0	N/A	21	12	57
MEAN C1	243			0			14		
STD DEV	19			0			10		
RSD	8			N/A			71		
C21W	68	29	43	30	17	57	0	0	N/A
C22W	110	31	28	40	17	43	35	12	34
C23W	59	29	49	0	0	N/A	27	12	44
MEAN C2	79			23			21		
STD DEV	22			17			15		
RSD	28			73			72		
C31W	145	33	23	24	20	83	0	0	N/A
C32W	140	33	24	49	20	41	0	0	N/A
C33W	170	34	20	48	20	42	0	0	N/A
MEAN C3	152			40			0		
STD DEV	13			12			0		
RSD	9			29			N/A		
C41W	207	36	17	39	20	51	13	12	92
C42W	177	34	19	0	0	N/A	0	0	N/A
C43W	80	31	39	0	0	N/A	0	0	N/A
MEAN C4	155			13			4		
STD DEV	54			18			6		
RSD	35			141			141		
C51W	53	27	51	55	17	31	0	0	N/A
C52W	100	28	28	31	16	52	12	10	83
C53W	50	26	52	27	16	59	22	11	50
MEAN C5	68			38			11		
STD DEV	23			12			9		
RSD	34			33			79		

STATION (Sample)	Sr ppm	Sr Std Dev	Sr RSD	Zr ppm	Zr Std Dev	Zr RSD	Mo ppm	Mo Std Dev	Mo RSD
A11W	216	9	4	241	6	2	0	0	N/A
A12W	221	9	4	231	6	3	3	3	87
A13W	214	9	4	239	7	3	0	0	N/A
MEAN A1	217			237			1		
STD DEV	3			4			1		
RSD	1			2			141		
A21W	133	8	6	137	5	4	0	0	N/A
A22W	120	7	6	133	5	4	0	0	N/A
A23W	165	8	5	187	6	3	0	0	N/A
MEAN A2	139			152			0		
STD DEV	19			25			0		
RSD	14			16			N/A		
A31W	196	9	4	134	5	4	0	0	N/A
A32W	184	9	5	140	5	4	3	2	73
A33W	212	9	4	99	5	5	0	0	N/A
MEAN A3	197			124			1		
STD DEV	11			18			2		
RSD	6			15			141		
A41W	215	9	4	142	5	4	0	0	N/A
A42W	242	10	4	170	6	3	0	0	N/A
A43W	220	9	4	160	6	3	0	0	N/A
MEAN A4	226			157			0		
STD DEV	12			12			0		
RSD	5			7			N/A		
A51W	258	10	4	129	5	4	3	2	68
A52W	232	9	4	149	5	4	3	2	70
A53W	254	10	4	133	5	4	0	0	N/A
MEAN A5	248			137			2		
STD DEV	11			9			2		
RSD	5			6			71		

STATION (Sample)	Sr ppm	Sr Std Dev	Sr RSD	Zr ppm	Zr Std Dev	Zr RSD	Mo ppm	Mo Std Dev	Mo RSD
B11W	116	7	6	84	4	5	0	0	N/A
B12W	118	7	6	94	5	5	0	0	N/A
B13W	111	7	6	75	4	6	0	0	N/A
MEAN B1	115			84			0		
STD DEV	3			8			0		
RSD	3			9			N/A		
B21W	180	9	5	106	5	5	0	0	N/A
B22W	205	9	4	108	5	4	3	3	86
B23W	170	8	5	150	5	4	0	0	N/A
MEAN B2	185			121			1		
STD DEV	15			20			1		
RSD	8			17			141		
B31W	127	7	6	82	4	5	0	0	N/A
B32W	149	8	5	114	5	4	4	3	62
B33W	137	8	6	102	5	5	3	3	93
MEAN B3	138			99			2		
STD DEV	9			13			2		
RSD	7			13			75		
B41W	184	9	5	143	5	4	0	0	N/A
B42W	204	9	4	158	6	3	0	0	N/A
B43W	182	9	5	157	5	3	4	3	75
MEAN B4	190			153			1		
STD DEV	10			7			2		
RSD	5			4			141		
B51W	219	9	4	122	5	4	0	0	N/A
B52W	230	9	4	135	5	4	0	0	N/A
B53W	225	9	4	129	5	4	4	2	50
MEAN B5	225			129			1		
STD DEV	4			5			2		
RSD	2			4			141		

STATION (Sample)	Sr ppm	Sr Std Dev	Sr RSD	Zr ppm	Zr Std Dev	Zr RSD	Mo ppm	Mo Std Dev	Mo RSD
C11W	183	9	5	131	5	4	0	0	N/A
C12W	162	8	5	135	5	4	3	2	67
C13W	168	8	5	141	5	4	6	3	50
MEAN C1	171			136			3		
STD DEV	9			4			2		
RSD	5			3			82		
C21W	223	10	4	154	6	4	0	0	N/A
C22W	225	10	4	116	5	4	0	0	N/A
C23W	239	10	4	119	5	4	0	0	N/A
MEAN C2	229			130			0		
STD DEV	7			17			0		
RSD	3			13			N/A		
C31W	150	8	5	121	5	4	0	0	N/A
C32W	188	9	5	99	5	5	0	0	N/A
C33W	162	8	5	94	5	5	0	0	N/A
MEAN C3	167			105			0		
STD DEV	16			12			0		
RSD	10			11			N/A		
C41W	126	7	6	110	5	5	0	0	N/A
C42W	124	7	6	94	5	5	0	0	N/A
C43W	114	7	6	100	5	5	0	0	N/A
MEAN C4	121			101			0		
STD DEV	5			7			0		
RSD	4			7			N/A		
C51W	182	8	4	114	5	4	0	0	N/A
C52W	181	8	4	96	4	4	0	0	N/A
C53W	176	8	5	88	4	5	0	0	N/A
MEAN C5	180			99			0		
STD DEV	3			11			0		
RSD	1			11			N/A		

STATION (Sample)	Hg ppm	Hg Std Dev	Hg RSD	Pb ppm	Pb Std Dev	Pb RSD	Rb ppm	Rb Std Dev	Rb RSD
A11W	0	0	N/A	33	12	37	73	9	12
A12W	48	26	53	57	13	23	74	9	12
A13W	0	0	N/A	48	13	27	74	9	12
MEAN A1	16			46			73		
STD DEV	23			10			0		
RSD	141			21			1		
A21W	39	27	71	92	15	17	77	9	12
A22W	0	0	N/A	79	14	18	88	9	11
A23W	0	0	N/A	86	15	17	87	9	11
MEAN A2	13			86			84		
STD DEV	18			5			5		
RSD	141			6			6		
A31W	0	0	N/A	25	11	45	73	9	12
A32W	32	25	79	0	0	N/A	70	8	12
A33W	0	0	N/A	31	12	39	59	8	14
MEAN A3	11			19			68		
STD DEV	15			13			6		
RSD	141			72			9		
A41W	0	0	N/A	26	11	43	54	8	15
A42W	0	0	N/A	0	0	N/A	59	8	14
A43W	43	25	59	0	0	N/A	43	8	18
MEAN A4	14			9			52		
STD DEV	20			12			6		
RSD	141			141			12		
A51W	0	0	N/A	34	11	32	50	7	15
A52W	0	0	N/A	0	0	N/A	56	8	14
A53W	0	0	N/A	0	0	N/A	56	8	13
MEAN A5	0			11			54		
STD DEV	0			16			3		
RSD	N/A			141			5		

STATION (Sample)	Hg ppm	Hg Std Dev	Hg RSD	Pb ppm	Pb Std Dev	Pb RSD	Rb ppm	Rb Std Dev	Rb RSD
B11W	0	0	N/A	69	14	21	98	10	10
B12W	0	0	N/A	115	16	14	87	9	11
B13W	0	0	N/A	50	13	26	87	9	11
MEAN B1	0			78			91		
STD DEV	0			27			5		
RSD	N/A			35			6		
B21W	0	0	N/A	24	12	49	68	8	12
B22W	27	26	94	21	12	57	72	9	12
B23W	0	0	N/A	34	12	36	73	9	12
MEAN B2	9			26			71		
STD DEV	13			6			2		
RSD	141			22			3		
B31W	0	0	N/A	38	13	34	89	9	11
B32W	0	0	N/A	19	12	63	101	10	10
B33W	0	0	N/A	35	12	35	92	10	10
MEAN B3	0			31			94		
STD DEV	0			8			5		
RSD	N/A			27			5		
B41W	0	0	N/A	25	11	45	64	8	13
B42W	0	0	N/A	28	12	42	72	9	12
B43W	33	26	79	16	11	69	84	9	11
MEAN B4	11			23			73		
STD DEV	16			5			8		
RSD	141			23			11		
B51W	0	0	N/A	0	0	N/A	62	8	13
B52W	0	0	N/A	0	0	N/A	40	7	18
B53W	0	0	N/A	22	11	50	44	7	16
MEAN B5	0			7			49		
STD DEV	0			10			10		
RSD	N/A			141			20		

STATION (Sample)	Hg ppm	Hg Std Dev	Hg RSD	Pb ppm	Pb Std Dev	Pb RSD	Rb ppm	Rb Std Dev	Rb RSD
C11W	0	0	N/A	74	14	19	68	9	13
C12W	0	0	N/A	51	13	25	71	9	13
C13W	0	0	N/A	90	15	17	81	9	11
MEAN C1	0			72			73		
STD DEV	0			16			6		
RSD	N/A			22			8		
C21W	0	0	N/A	0	0	N/A	62	9	15
C22W	0	0	N/A	0	0	N/A	54	8	15
C23W	27	26	96	0	0	N/A	60	8	13
MEAN C2	9			0			59		
STD DEV	13			0			3		
RSD	141			N/A			6		
C31W	0	0	N/A	40	13	33	90	10	11
C32W	0	0	N/A	0	0	N/A	89	10	11
C33W	0	0	N/A	15	11	73	77	9	12
MEAN C3	0			18			85		
STD DEV	0			16			6		
RSD	N/A			90			7		
C41W	0	0	N/A	14	12	86	91	10	11
C42W	49	27	55	39	13	33	60	7	12
C43W	0	0	N/A	12	12	100	61	9	15
MEAN C4	16			22			71		
STD DEV	23			12			14		
RSD	141			57			20		
C51W	37	24	65	0	0	N/A	41	7	17
C52W	0	0	N/A	0	0	N/A	29	7	24
C53W	24	23	96	0	0	N/A	20	7	35
MEAN C5	20			0			30		
STD DEV	15			0			9		
RSD	75			N/A			29		

STATION (Sample)	Cd ppm	Cd Std Dev	Cd RSD	Ba ppm	Ba Std Dev	Ba RSD	Ag ppm	Ag Std Dev	Ag RSD
A11W	0	0	N/A	392	10	3	92	26	28
A12W	109	42	38	381	10	3	77	26	34
A13W	0	0	N/A	386	10	3	86	26	31
MEAN A1	36			386			85		
STD DEV	51			4			6		
RSD	141			1			7		
A21W	53	42	79	232	9	4	72	27	37
A22W	0	0	N/A	217	8	4	77	26	33
A23W	0	0	N/A	254	9	3	49	26	54
MEAN A2	18			234			66		
STD DEV	25			15			12		
RSD	141			6			19		
A31W	61	39	63	238	8	3	137	25	19
A32W	0	0	N/A	273	9	3	98	26	26
A33W	0	0	N/A	255	9	3	57	26	45
MEAN A3	20			255			97		
STD DEV	29			14			32		
RSD	141			6			33		
A41W	0	0	N/A	317	10	3	94	27	29
A42W	0	0	N/A	340	10	3	78	27	34
A43W	0	0	N/A	347	10	3	73	26	36
MEAN A4	0			335			81		
STD DEV	0			13			9		
RSD	N/A			4			11		
A51W	72	39	54	302	9	3	149	26	17
A52W	0	0	N/A	305	9	3	63	25	39
A53W	106	40	37	320	9	3	66	25	37
MEAN A5	59			309			93		
STD DEV	44			8			40		
RSD	74			3			43		

STATION (Sample)	Cd ppm	Cd Std Dev	Cd RSD	Ba ppm	Ba Std Dev	Ba RSD	Ag ppm	Ag Std Dev	Ag RSD
B11W	0	0	N/A	141	7	5	95	26	28
B12W	0	0	N/A	149	7	5	102	27	26
B13W	0	0	N/A	137	7	5	56	26	46
MEAN B1	0			142			84		
STD DEV	0			5			20		
RSD	N/A			4			24		
B21W	91	42	46	264	9	3	116	27	23
B22W	0	0	N/A	275	9	3	105	27	26
B23W	59	42	71	250	9	3	87	27	31
MEAN B2	50			263			103		
STD DEV	38			10			12		
RSD	75			4			12		
B31W	0	0	N/A	214	8	4	86	27	31
B32W	0	0	N/A	190	8	4	90	26	29
B33W	0	0	N/A	216	8	4	83	27	33
MEAN B3	0			207			86		
STD DEV	0			12			3		
RSD	N/A			6			3		
B41W	71	41	58	269	9	3	78	26	34
B42W	0	0	N/A	304	10	3	107	28	26
B43W	0	0	N/A	276	9	3	134	26	19
MEAN B4	24			283			106		
STD DEV	34			15			23		
RSD	141			5			22		
B51W	0	0	N/A	265	9	3	125	25	20
B52W	0	0	N/A	309	9	3	91	25	27
B53W	0	0	N/A	292	9	3	81	25	31
MEAN B5	0			289			99		
STD DEV	0			18			19		
RSD	N/A			6			19		

STATION (Sample)	Cd ppm	Cd Std Dev	Cd RSD	Ba ppm	Ba Std Dev	Ba RSD	Ag ppm	Ag Std Dev	Ag RSD
C11W	0	0	N/A	250	9	4	64	27	42
C12W	0	0	N/A	261	9	3	78	27	35
C13W	0	0	N/A	247	9	4	115	27	23
MEAN C1	0			253			86		
STD DEV	0			6			22		
RSD	N/A			2			25		
C21W	0	0	N/A	453	12	3	126	29	23
C22W	84	44	52	410	11	3	92	28	30
C23W	0	0	N/A	395	11	3	75	29	39
MEAN C2	28			419			98		
STD DEV	40			25			21		
RSD	141			6			22		
C31W	0	0	N/A	214	8	4	104	28	27
C32W	110	44	40	236	9	4	129	28	22
C33W	0	0	N/A	246	9	4	67	27	40
MEAN C3	37			232			100		
STD DEV	52			13			25		
RSD	141			6			25		
C41W	0	0	N/A	197	8	4	71	27	38
C42W	0	0	N/A	191	8	4	119	26	22
C43W	0	0	N/A	203	8	4	108	26	24
MEAN C4	0			197			99		
STD DEV	0			5			21		
RSD	N/A			2			21		
C51W	0	0	N/A	330	9	3	111	26	23
C52W	0	0	N/A	289	9	3	110	24	22
C53W	0	0	N/A	332	9	3	0	0	N/A
MEAN C5	0			317			74		
STD DEV	0			20			52		
RSD	N/A			6			71		

STATION (Sample)	U ppm	U Std Dev	U RSD	Th ppm	Th Std Dev	Th RSD	Sb ppm	Sb Std Dev	Sb RSD
A11W	0	0	N/A	21	5	23	0	0	N/A
A12W	12	7	59	14	5	35	0	0	N/A
A13W	0	0	N/A	13	5	35	0	0	N/A
MEAN A1	4			16			0		
STD DEV	6			3			0		
RSD	141			22			N/A		
A21W	0	0	N/A	13	5	34	0	0	N/A
A22W	0	0	N/A	14	5	34	17	14	86
A23W	0	0	N/A	10	5	48	0	0	N/A
MEAN A2	0			12			6		
STD DEV	0			2			8		
RSD	N/A			15			141		
A31W	0	0	N/A	0	0	N/A	0	0	N/A
A32W	0	0	N/A	16	4	28	0	0	N/A
A33W	10	7	64	11	4	39	0	0	N/A
MEAN A3	3			9			0		
STD DEV	5			7			0		
RSD	141			73			N/A		
A41W	0	0	N/A	4	4	100	0	0	N/A
A42W	0	0	N/A	0	0	N/A	0	0	N/A
A43W	10	6	65	17	5	27	0	0	N/A
MEAN A4	3			7			0		
STD DEV	5			7			0		
RSD	141			101			N/A		
A51W	0	0	N/A	0	0	N/A	0	0	N/A
A52W	0	0	N/A	13	4	33	0	0	N/A
A53W	0	0	N/A	7	4	58	0	0	N/A
MEAN A5	0			7			0		
STD DEV	0			5			0		
RSD	N/A			79			N/A		

STATION (Sample)	U ppm	U Std Dev	U RSD	Th ppm	Th Std Dev	Th RSD	Sb ppm	Sb Std Dev	Sb RSD
B11W	0	0	N/A	11	4	41	0	0	N/A
B12W	0	0	N/A	5	4	92	0	0	N/A
B13W	0	0	N/A	12	4	38	0	0	N/A
MEAN B1	0			9			0		
STD DEV	0			3			0		
RSD	N/A			33			N/A		
B21W	0	0	N/A	9	4	46	0	0	N/A
B22W	0	0	N/A	5	4	82	0	0	N/A
B23W	0	0	N/A	10	4	44	21	15	74
MEAN B2	0			8			7		
STD DEV	0			2			10		
RSD	N/A			26			141		
B31W	0	0	N/A	13	4	34	0	0	N/A
B32W	0	0	N/A	15	5	30	0	0	N/A
B33W	0	0	N/A	6	4	71	23	15	68
MEAN B3	0			11			8		
STD DEV	0			4			11		
RSD	N/A			35			141		
B41W	0	0	N/A	7	4	61	0	0	N/A
B42W	10	7	66	0	0	N/A	0	0	N/A
B43W	0	0	N/A	7	4	57	0	0	N/A
MEAN B4	3			5			0		
STD DEV	5			3			0		
RSD	141			71			N/A		
B51W	0	0	N/A	0	0	N/A	0	0	N/A
B52W	0	0	N/A	0	0	N/A	0	0	N/A
B53W	0	0	N/A	0	0	N/A	0	0	N/A
MEAN B5	0			0			0		
STD DEV	0			0			0		
RSD	N/A			N/A			N/A		

STATION (Sample)	U ppm	U Std Dev	U RSD	Th ppm	Th Std Dev	Th RSD	Sb ppm	Sb Std Dev	Sb RSD
C11W	0	0	N/A	0	0	N/A	0	0	N/A
C12W	0	0	N/A	16	4	25	0	0	N/A
C13W	0	0	N/A	0	0	N/A	0	0	N/A
MEAN C1	0			5			0		
STD DEV	0			8			0		
RSD	N/A			141			N/A		
C21W	11	6	55	0	0	N/A	24	16	67
C22W	0	0	N/A	6	4	67	0	0	N/A
C23W	0	0	N/A	9	4	44	0	0	N/A
MEAN C2	4			5			8		
STD DEV	5			4			11		
RSD	141			75			141		
C31W	0	0	N/A	10	4	40	0	0	N/A
C32W	0	0	N/A	22	5	23	0	0	N/A
C33W	0	0	N/A	4	4	100	0	0	N/A
MEAN C3	0			12			0		
STD DEV	0			7			0		
RSD	N/A			62			N/A		
C41W	0	0	N/A	9	4	44	0	0	N/A
C42W	20	7	35	25	5	20	0	0	N/A
C43W	15	7	47	31	5	16	0	0	N/A
MEAN C4	12			22			0		
STD DEV	8			9			0		
RSD	73			43			N/A		
C51W	18	7	39	18	5	28	0	0	N/A
C52W	23	6	26	31	5	16	0	0	N/A
C53W	31	7	23	29	5	17	0	0	N/A
MEAN C5	24			26			0		
STD DEV	5			6			0		
RSD	22			22			N/A		

STATION (Sample)	Sn ppm	Sn Std Dev	Sn RSD
A11W	0	0	N/A
A12W	0	0	N/A
A13W	0	0	N/A
MEAN A1	0		
STD DEV	0		
RSD	N/A		
A21W	0	0	N/A
A22W	0	0	N/A
A23W	0	0	N/A
MEAN A2	0		
STD DEV	0		
RSD	N/A		
A31W	0	0	N/A
A32W	0	0	N/A
A33W	0	0	N/A
MEAN A3	0		
STD DEV	0		
RSD	N/A		
A41W	0	0	N/A
A42W	0	0	N/A
A43W	0	0	N/A
MEAN A4	0		
STD DEV	0		
RSD	N/A		
A51W	0	0	N/A
A52W	0	0	N/A
A53W	0	0	N/A
MEAN A5	0		
STD DEV	0		
RSD	N/A		

STATION (Sample)	Sn ppm	Sn Std Dev	Sn RSD
B11W	0	0	N/A
B12W	0	0	N/A
B13W	0	0	N/A
MEAN B1	0		
STD DEV	0		
RSD	N/A		
B21W	0	0	N/A
B22W	0	0	N/A
B23W	0	0	N/A
MEAN B2	0		
STD DEV	0		
RSD	N/A		
B31W	0	0	N/A
B32W	0	0	N/A
B33W	0	0	N/A
MEAN B3	0		
STD DEV	0		
RSD	N/A		
B41W	15	12	79
B42W	0	0	N/A
B43W	0	0	N/A
MEAN B4	5		
STD DEV	7		
RSD	141		
B51W	0	0	N/A
B52W	0	0	N/A
B53W	0	0	N/A
MEAN B5	0		
STD DEV	0		
RSD	N/A		

STATION (Sample)	Sn ppm	Sn Std Dev	Sn RSD
C11W	0	0	N/A
C12W	0	0	N/A
C13W	0	0	N/A
MEAN C1	0		
STD DEV	0		
RSD	N/A		
C21W	0	0	N/A
C22W	0	0	N/A
C23W	0	0	N/A
MEAN C2	0		
STD DEV	0		
RSD	N/A		
C31W	0	0	N/A
C32W	0	0	N/A
C33W	0	0	N/A
MEAN C3	0		
STD DEV	0		
RSD	N/A		
C41W	0	0	N/A
C42W	0	0	N/A
C43W	0	0	N/A
MEAN C4	0		
STD DEV	0		
RSD	N/A		
C51W	16	12	75
C52W	0	0	N/A
C53W	0	0	N/A
MEAN C5	5		
STD DEV	8		
RSD	141		

XRF FIELD TEST---SEA TRIALS---JULY 2, 1993---WET SEDIMENTS---LABORATORY MEASUREMENTS

STATION (Sample)	Cr ppm	Cr Std Dev	Cr RSD	K ppm	K Std Dev	K RSD	Ca ppm	Ca Std Dev	Ca RSD
D11W	0	0	N/A	11073	634	6	7471	345	5
D12W	0	0	N/A	9782	603	6	8079	353	4
D13W	0	0	N/A	11721	647	6	7072	338	5
MEAN D1	0			10859			7541		
STD DEV	0			806			414		
RSD	N/A			7			5		
D21W	0	0	N/A	15555	732	5	9550	390	4
D22W	0	0	N/A	16798	755	4	8979	382	4
D23W	0	0	N/A	15405	729	5	9937	396	4
MEAN D2	0			15919			9489		
STD DEV	0			624			393		
RSD	N/A			4			4		
D31W	0	0	N/A	16784	756	5	9572	392	4
D32W	0	0	N/A	17046	760	4	8272	371	4
D33W	0	0	N/A	14409	709	5	9762	391	4
MEAN D3	0			16080			9202		
STD DEV	0			1186			662		
RSD	N/A			7			7		
D41W	0	0	N/A	11592	647	6	9234	377	4
D42W	0	0	N/A	11132	643	6	14343	454	3
D43W	0	0	N/A	12181	664	5	12341	427	3
MEAN D4	0			11635			11973		
STD DEV	0			429			2102		
RSD	N/A			4			18		
D51W	0	0	N/A	10799	635	6	14891	461	3
D52W	0	0	N/A	10178	624	6	16198	478	3
D53W	0	0	N/A	12272	665	5	11546	415	4
MEAN D5	0			11083			14212		
STD DEV	0			878			1959		
RSD	N/A			8			14		

XRF FIELD TEST---SEA TRIALS---JULY 2, 1993---WET SEDIMENTS---LABORATORY MEASUREMENTS

STATION (Sample)	Cr ppm	Cr Std Dev	Cr RSD	K ppm	K Std Dev	K RSD	Ca ppm	Ca Std Dev	Ca RSD
E11W	0	0	N/A	13574	692	5	10338	399	4
E12W	0	0	N/A	12397	666	5	10296	396	4
E13W	0	0	N/A	12340	665	5	9897	389	4
MEAN E1	0			12770			10177		
STD DEV	0			569			199		
RSD	N/A			4			2		
E21W	0	0	N/A	13003	675	5	6814	336	5
E22W	0	0	N/A	10564	621	6	7730	348	5
E23W	0	0	N/A	11078	634	6	8267	359	4
MEAN E2	0			11548			7604		
STD DEV	0			1050			600		
RSD	N/A			9			8		
E31W	0	0	N/A	12340	662	5	7555	348	5
E32W	0	0	N/A	13139	680	5	7857	356	5
E33W	0	0	N/A	14040	698	5	7063	343	5
MEAN E3	0			13173			7492		
STD DEV	0			694			327		
RSD	N/A			5			4		
E41W	0	0	N/A	12815	672	5	7622	350	5
E42W	0	0	N/A	13236	680	5	6307	327	5
E43W	0	0	N/A	11841	651	5	7908	354	4
MEAN E4	0			12631			7279		
STD DEV	0			584			697		
RSD	N/A			5			10		
E51W	0	0	N/A	12522	670	5	11819	420	4
E52W	0	0	N/A	12520	671	5	12277	427	3
E53W	0	0	N/A	10989	633	6	9606	381	4
MEAN E5	0			12010			11234		
STD DEV	0			722			1166		
RSD	N/A			6			10		

XRF FIELD TEST---SEA TRIALS---JULY 2, 1993---WET SEDIMENTS---LABORATORY MEASUREMENTS

STATION (Sample)	Cr ppm	Cr Std Dev	Cr RSD	K ppm	K Std Dev	K RSD	Ca ppm	Ca Std Dev	Ca RSD
F11W	0	0	N/A	13470	690	5	10470	401	4
F12W	0	0	N/A	12053	658	5	10270	395	4
F13W	0	0	N/A	11654	648	6	9242	377	4
MEAN F1	0			12392			9994		
STD DEV	0			779			538		
RSD	N/A			6			5		
F21W	0	0	N/A	9729	610	6	14450	453	3
F22W	0	0	N/A	9577	599	6	8967	368	4
F23W	0	0	N/A	11119	635	6	8885	369	4
MEAN F2	0			10142			10767		
STD DEV	0			694			2604		
RSD	N/A			7			24		
F31W	0	0	N/A	9485	598	6	9761	381	4
F32W	0	0	N/A	10692	627	6	10332	393	4
F33W	0	0	N/A	10389	618	6	8389	359	4
MEAN F3	0			10189			9494		
STD DEV	0			513			815		
RSD	N/A			5			9		
F41W	0	0	N/A	9841	608	6	11571	411	4
F42W	0	0	N/A	10166	617	6	11879	416	4
F43W	0	0	N/A	10754	627	6	9105	372	4
MEAN F4	0			10254			10852		
STD DEV	0			378			1241		
RSD	N/A			4			11		
F51W	0	0	N/A	11807	651	6	8964	372	4
F52W	0	0	N/A	10042	614	6	11337	408	4
F53W	0	0	N/A	10964	634	6	10342	394	4
MEAN F5	0			10938			10214		
STD DEV	0			721			973		
RSD	N/A			7			10		

STATION (Sample)	Tl ppm	Tl Std Dev	Tl RSD	Mn ppm	Mn Std Dev	Mn RSD	Fe ppm	Fe Std Dev	Fe RSD
D11W	2631	223	8	0	0	N/A	33988	555	2
D12W	2046	216	11	465	196	42	34131	555	2
D13W	2574	222	9	547	195	36	34042	555	2
MEAN D1	2417			337			34054		
STD DEV	263			241			59		
RSD	11			71			0		
D21W	3011	245	8	620	202	33	36129	580	2
D22W	3135	246	8	751	213	28	37674	594	2
D23W	3345	243	7	387	192	50	37180	588	2
MEAN D2	3164			586			36994		
STD DEV	138			151			644		
RSD	4			26			2		
D31W	3544	246	7	721	216	30	37122	591	2
D32W	3394	245	7	783	215	27	37660	594	2
D33W	2577	240	9	483	196	41	34432	564	2
MEAN D3	3172			662			36405		
STD DEV	425			129			1412		
RSD	13			20			4		
D41W	2232	205	9	472	185	39	23641	461	2
D42W	2531	211	8	799	197	25	19780	424	2
D43W	284	213	75	509	186	37	21667	443	2
MEAN D4	1682			593			21696		
STD DEV	996			146			1576		
RSD	59			25			7		
D51W	1898	192	10	574	184	32	17296	396	2
D52W	2437	214	9	575	186	32	18373	409	2
D53W	2182	201	9	416	177	43	18902	413	2
MEAN D5	2172			522			18190		
STD DEV	220			75			668		
RSD	10			14			4		

STATION (Sample)	Tl ppm	Tl Std Dev	Tl RSD	Mn ppm	Mn Std Dev	Mn RSD	Fe ppm	Fe Std Dev	Fe RSD
E11W	3019	228	8	630	203	32	33158	553	2
E12W	2515	222	9	442	188	43	32448	543	2
E13W	2451	227	9	399	187	47	32720	546	2
MEAN E1	2662			490			32775		
STD DEV	254			100			292		
RSD	10			20			1		
E21W	3020	228	8	267	186	70	34765	563	2
E22W	2409	221	9	450	189	42	33389	548	2
E23W	2849	220	8	379	190	50	33478	551	2
MEAN E2	2759			365			33877		
STD DEV	257			75			629		
RSD	9			21			2		
E31W	2102	210	10	653	198	30	29710	518	2
E32W	2881	226	8	801	205	26	30861	530	2
E33W	2679	228	9	841	209	25	32031	541	2
MEAN E3	2554			765			30867		
STD DEV	330			81			948		
RSD	13			11			3		
E41W	2761	217	8	771	207	27	33840	555	2
E42W	2147	220	10	767	204	27	32718	545	2
E43W	2368	218	9	238	181	76	31226	531	2
MEAN E4	2425			592			32595		
STD DEV	254			250			1071		
RSD	10			42			3		
E51W	2058	206	10	277	173	62	23813	464	2
E52W	2081	208	10	0	0	N/A	22919	455	2
E53W	2048	208	10	438	176	40	23067	454	2
MEAN E5	2062			238			23266		
STD DEV	14			181			391		
RSD	1			76			2		

STATION (Sample)	Tl ppm	Tl Std Dev	Tl RSD	Mn ppm	Mn Std Dev	Mn RSD	Fe ppm	Fe Std Dev	Fe RSD
F11W	2671	218	8	443	187	42	25862	486	2
F12W	2330	219	9	305	171	56	23262	458	2
F13W	2382	217	9	241	168	70	24497	469	2
MEAN F1	2461			330			24540		
STD DEV	150			84			1062		
RSD	6			26			4		
F21W	2269	199	9	593	181	31	16259	383	2
F22W	1906	196	10	0	0	N/A	19980	421	2
F23W	1599	188	12	488	179	37	19274	415	2
MEAN F2	1925			360			18504		
STD DEV	274			258			1614		
RSD	14			72			9		
F31W	1949	187	10	841	194	23	17923	400	2
F32W	1835	187	10	335	164	49	18814	409	2
F33W	1803	201	11	478	178	37	19476	416	2
MEAN F3	1862			551			18738		
STD DEV	63			213			636		
RSD	3			39			3		
F41W	1736	178	10	467	172	37	16122	379	2
F42W	1443	184	13	438	172	39	17110	391	2
F43W	1949	192	10	316	171	54	18667	408	2
MEAN F4	1709			407			17300		
STD DEV	207			65			1048		
RSD	12			16			6		
F51W	1716	197	11	480	180	38	19510	418	2
F52W	1851	192	10	612	188	31	20880	433	2
F53W	1984	199	10	511	180	35	20043	424	2
MEAN F5	1850			534			20144		
STD DEV	109			56			564		
RSD	6			11			3		

STATION (Sample)	Co ppm	Co Std Dev	Co RSD	Ni ppm	Ni Std Dev	Ni RSD	Cu ppm	Cu Std Dev	Cu RSD
D11W	185	185	100	0	0	N/A	199	41	21
D12W	298	187	63	0	0	N/A	179	40	22
D13W	256	187	73	0	0	N/A	121	38	31
MEAN D1	246			0			166		
STD DEV	47			0			33		
RSD	19			N/A			20		
D21W	348	195	56	0	0	N/A	0	0	N/A
D22W	211	196	93	0	0	N/A	65	36	55
D23W	538	201	37	0	0	N/A	0	0	N/A
MEAN D2	366			0			22		
STD DEV	134			0			31		
RSD	37			N/A			141		
D31W	0	0	N/A	78	61	78	89	37	42
D32W	0	0	N/A	0	0	N/A	70	36	51
D33W	241	188	78	0	0	N/A	102	36	35
MEAN D3	80			26			87		
STD DEV	114			37			13		
RSD	141			141			15		
D41W	0	0	N/A	0	0	N/A	65	32	49
D42W	0	0	N/A	0	0	N/A	0	0	N/A
D43W	0	0	N/A	0	0	N/A	41	31	76
MEAN D4	0			0			35		
STD DEV	0			0			27		
RSD	N/A			N/A			76		
D51W	0	0	N/A	0	0	N/A	40	30	75
D52W	186	144	77	0	0	N/A	0	0	N/A
D53W	0	0	N/A	133	54	41	96	33	34
MEAN D5	62			44			45		
STD DEV	88			63			39		
RSD	141			141			87		

STATION (Sample)	Co ppm	Co Std Dev	Co RSD	Ni ppm	Ni Std Dev	Ni RSD	Cu ppm	Cu Std Dev	Cu RSD
E11W	402	188	47	0	0	N/A	184	40	22
E12W	308	183	59	0	0	N/A	178	40	22
E13W	284	184	65	0	0	N/A	246	42	17
MEAN E1	331			0			203		
STD DEV	51			0			31		
RSD	15			N/A			15		
E21W	467	192	41	0	0	N/A	255	43	17
E22W	496	189	38	82	61	74	386	48	12
E23W	188	184	98	116	62	53	299	45	15
MEAN E2	384			66			313		
STD DEV	139			49			54		
RSD	36			74			17		
E31W	405	179	44	0	0	N/A	89	34	38
E32W	218	178	82	0	0	N/A	0	0	N/A
E33W	0	0	N/A	0	0	N/A	104	37	36
MEAN E3	208			0			64		
STD DEV	166			0			46		
RSD	80			N/A			71		
E41W	0	0	N/A	0	0	N/A	145	39	27
E42W	261	184	70	0	0	N/A	113	37	33
E43W	385	182	47	0	0	N/A	115	37	32
MEAN E4	215			0			124		
STD DEV	160			0			15		
RSD	75			N/A			12		
E51W	0	0	N/A	0	0	N/A	58	32	55
E52W	0	0	N/A	88	54	61	66	33	50
E53W	0	0	N/A	85	53	62	93	33	35
MEAN E5	0			58			72		
STD DEV	0			41			15		
RSD	N/A			71			21		

STATION (Sample)	Co ppm	Co Std Dev	Co RSD	Ni ppm	Ni Std Dev	Ni RSD	Cu ppm	Cu Std Dev	Cu RSD
F11W	0	0	N/A	0	0	N/A	93	35	38
F12W	163	157	96	0	0	N/A	47	32	68
F13W	0	0	N/A	0	0	N/A	125	35	28
MEAN F1	54			0			88		
STD DEV	77			0			32		
RSD	141			N/A			36		
F21W	0	0	N/A	0	0	N/A	0	0	N/A
F22W	0	0	N/A	0	0	N/A	0	0	N/A
F23W	214	146	68	0	0	N/A	44	31	70
MEAN F2	71			0			15		
STD DEV	101			0			21		
RSD	141			N/A			141		
F31W	0	0	N/A	0	0	N/A	62	31	50
F32W	0	0	N/A	0	0	N/A	30	30	100
F33W	161	145	90	0	0	N/A	57	31	54
MEAN F3	54			0			50		
STD DEV	76			0			14		
RSD	141			N/A			28		
F41W	0	0	N/A	78	51	65	39	30	77
F42W	0	0	N/A	83	52	63	0	0	N/A
F43W	0	0	N/A	78	52	67	65	32	49
MEAN F4	0			80			35		
STD DEV	0			2			27		
RSD	N/A			3			77		
F51W	348	150	43	0	0	N/A	87	33	38
F52W	248	152	61	0	0	N/A	75	33	44
F53W	0	0	N/A	0	0	N/A	31	30	97
MEAN F5	199			0			64		
STD DEV	146			0			24		
RSD	74			N/A			37		

STATION (Sample)	Zn ppm	Zn Std Dev	Zn RSD	As ppm	As Std Dev	As RSD	Se ppm	Se Std Dev	Se RSD
D11W	243	38	16	0	0	N/A	0	0	N/A
D12W	221	37	17	0	0	N/A	22	13	59
D13W	249	38	15	0	0	N/A	0	0	N/A
MEAN D1	238			0			7		
STD DEV	12			0			10		
RSD	5			N/A			141		
D21W	78	32	41	0	0	N/A	0	0	N/A
D22W	146	35	24	0	0	N/A	22	13	59
D23W	91	33	36	36	20	56	17	13	76
MEAN D2	105			12			13		
STD DEV	29			17			9		
RSD	28			141			72		
D31W	113	33	29	38	20	53	34	13	38
D32W	139	34	24	25	20	80	0	0	N/A
D33W	175	34	19	0	0	N/A	0	0	N/A
MEAN D3	142			21			11		
STD DEV	25			16			16		
RSD	18			75			141		
D41W	150	32	21	43	18	42	0	0	N/A
D42W	91	29	32	0	0	N/A	25	11	44
D43W	53	28	53	32	17	53	19	11	58
MEAN D4	98			25			15		
STD DEV	40			18			11		
RSD	41			73			73		
D51W	83	28	34	0	0	N/A	17	11	65
D52W	115	30	26	0	0	N/A	19	11	58
D53W	60	28	47	0	0	N/A	25	11	44
MEAN D5	86			0			20		
STD DEV	23			0			3		
RSD	26			N/A			17		

STATION (Sample)	Zn ppm	Zn Std Dev	Zn RSD	As ppm	As Std Dev	As RSD	Se ppm	Se Std Dev	Se RSD
E11W	248	37	15	0	0	N/A	0	0	N/A
E12W	181	34	19	0	0	N/A	0	0	N/A
E13W	218	36	17	48	22	46	0	0	N/A
MEAN E1	216			16			0		
STD DEV	27			23			0		
RSD	13			141			N/A		
E21W	106	33	31	0	0	N/A	0	0	N/A
E22W	184	36	20	0	0	N/A	0	0	N/A
E23W	202	37	18	49	21	43	24	13	54
MEAN E2	164			16			8		
STD DEV	42			23			11		
RSD	25			141			141		
E31W	104	31	30	0	0	N/A	0	0	N/A
E32W	159	34	21	35	19	54	16	12	75
E33W	210	36	17	19	19	100	0	0	N/A
MEAN E3	158			18			5		
STD DEV	43			14			8		
RSD	27			79			141		
E41W	186	36	19	27	20	74	0	0	N/A
E42W	192	36	19	21	19	90	0	0	N/A
E43W	200	36	18	64	20	31	0	0	N/A
MEAN E4	193			37			0		
STD DEV	6			19			0		
RSD	3			51			N/A		
E51W	88	29	33	43	18	42	0	0	N/A
E52W	0	0	N/A	0	0	N/A	13	11	85
E53W	101	29	29	31	17	55	0	0	N/A
MEAN E5	63			25			4		
STD DEV	45			18			6		
RSD	71			73			141		

STATION (Sample)	Zn ppm	Zn Std Dev	Zn RSD	As ppm	As Std Dev	As RSD	Se ppm	Se Std Dev	Se RSD
F11W	89	30	34	27	19	70	0	0	N/A
F12W	97	30	31	0	0	N/A	0	0	N/A
F13W	160	32	20	0	0	N/A	0	0	N/A
MEAN F1	115			9			0		
STD DEV	32			13			0		
RSD	28			141			N/A		
F21W	46	27	59	0	0	N/A	0	0	N/A
F22W	135	30	22	0	0	N/A	0	0	N/A
F23W	79	28	35	0	0	N/A	0	0	N/A
MEAN F2	87			0			0		
STD DEV	37			0			0		
RSD	42			N/A			N/A		
F31W	161	31	19	0	0	N/A	0	0	N/A
F32W	69	28	41	40	18	45	0	0	N/A
F33W	106	29	27	22	17	77	15	11	73
MEAN F3	112			21			5		
STD DEV	38			16			7		
RSD	34			79			141		
F41W	118	29	25	0	0	N/A	0	0	N/A
F42W	101	29	29	30	16	53	11	10	91
F43W	34	27	79	28	16	57	19	11	58
MEAN F4	84			19			10		
STD DEV	36			14			8		
RSD	43			71			78		
F51W	145	31	21	34	18	53	0	0	N/A
F52W	71	29	41	21	17	81	0	0	N/A
F53W	129	30	23	0	0	N/A	0	0	N/A
MEAN F5	115			18			0		
STD DEV	32			14			0		
RSD	28			76			N/A		

STATION (Sample)	Sr ppm	Sr Std Dev	Sr RSD	Zr ppm	Zr Std Dev	Zr RSD	Mo ppm	Mo Std Dev	Mo RSD
D11W	116	7	6	94	5	5	0	0	N/A
D12W	117	7	6	96	5	5	0	0	N/A
D13W	110	7	6	98	5	5	0	0	N/A
MEAN D1	114			96			0		
STD DEV	3			2			0		
RSD	3			2			N/A		
D21W	123	7	6	83	4	5	0	0	N/A
D22W	121	7	6	77	4	5	3	3	100
D23W	113	7	6	82	4	5	0	0	N/A
MEAN D2	119			81			1		
STD DEV	4			3			1		
RSD	4			3			141		
D31W	162	8	5	106	5	5	0	0	N/A
D32W	135	8	6	105	5	5	0	0	N/A
D33W	167	8	5	115	5	4	3	3	100
MEAN D3	155			109			1		
STD DEV	14			4			1		
RSD	9			4			141		
D41W	266	10	4	120	5	4	0	0	N/A
D42W	232	9	4	102	5	5	5	2	40
D43W	221	9	4	122	5	4	0	0	N/A
MEAN D4	240			115			2		
STD DEV	19			9			2		
RSD	8			8			141		
D51W	241	9	4	127	5	4	0	0	N/A
D52W	265	10	4	134	5	4	0	0	N/A
D53W	237	9	4	112	5	4	2	2	100
MEAN D5	248			124			1		
STD DEV	12			9			1		
RSD	5			7			141		

STATION (Sample)	Sr ppm	Sr Std Dev	Sr RSD	Zr ppm	Zr Std Dev	Zr RSD	Mo ppm	Mo Std Dev	Mo RSD
E11W	161	8	5	109	5	5	5	3	60
E12W	163	8	5	114	5	4	12	3	25
E13W	160	8	5	115	5	4	10	3	30
MEAN E1	161			113			9		
STD DEV	1			3			3		
RSD	1			2			33		
E21W	126	7	6	84	4	5	0	0	N/A
E22W	125	7	6	76	4	5	0	0	N/A
E23W	113	7	6	89	4	4	6	3	50
MEAN E2	121			83			2		
STD DEV	6			5			3		
RSD	5			6			141		
E31W	213	9	4	97	5	5	0	0	N/A
E32W	157	8	5	102	5	5	0	0	N/A
E33W	161	8	5	97	5	5	0	0	N/A
MEAN E3	177			99			0		
STD DEV	26			2			0		
RSD	14			2			N/A		
E41W	126	7	6	79	4	5	0	0	N/A
E42W	106	7	7	94	5	5	0	0	N/A
E43W	127	7	6	88	4	5	0	0	N/A
MEAN E4	120			87			0		
STD DEV	10			6			0		
RSD	8			7			N/A		
E51W	227	9	4	104	5	5	0	0	N/A
E52W	222	9	4	123	5	4	0	0	N/A
E53W	249	10	4	113	5	4	0	0	N/A
MEAN E5	233			113			0		
STD DEV	12			8			0		
RSD	5			7			N/A		

STATION (Sample)	Sr ppm	Sr Std Dev	Sr RSD	Zr ppm	Zr Std Dev	Zr RSD	Mo ppm	Mo Std Dev	Mo RSD
F11W	212	9	4	100	5	5	0	0	N/A
F12W	214	9	4	102	5	5	2	2	100
F13W	205	9	4	93	5	5	0	0	N/A
MEAN F1	210			98			1		
STD DEV	4			4			1		
RSD	2			4			141		
F21W	222	9	4	111	5	5	3	2	67
F22W	223	9	4	131	5	4	0	0	N/A
F23W	215	9	4	100	5	5	0	0	N/A
MEAN F2	220			114			1		
STD DEV	4			13			1		
RSD	2			11			141		
F31W	253	10	4	80	4	5	0	0	N/A
F32W	255	10	4	79	4	5	0	0	N/A
F33W	242	9	4	94	4	4	0	0	N/A
MEAN F3	250			84			0		
STD DEV	6			7			0		
RSD	2			8			N/A		
F41W	234	9	4	124	5	4	0	0	N/A
F42W	217	9	4	122	5	4	0	0	N/A
F43W	256	10	4	127	5	4	0	0	N/A
MEAN F4	236			124			0		
STD DEV	16			2			0		
RSD	7			2			N/A		
F51W	238	9	4	86	4	5	0	0	N/A
F52W	221	9	4	97	5	5	0	0	N/A
F53W	208	9	4	97	4	4	0	0	N/A
MEAN F5	222			93			0		
STD DEV	12			5			0		
RSD	6			6			N/A		

STATION (Sample)	Hg ppm	Hg Std Dev	Hg RSD	Pb ppm	Pb Std Dev	Pb RSD	Rb ppm	Rb Std Dev	Rb RSD
D11W	0	0	N/A	59	14	24	66	9	14
D12W	0	0	N/A	18	12	67	82	9	11
D13W	0	0	N/A	36	12	33	88	10	11
MEAN D1	0			38			79		
STD DEV	0			17			9		
RSD	N/A			45			12		
D21W	0	0	N/A	19	12	63	83	10	12
D22W	0	0	N/A	27	13	48	110	10	9
D23W	0	0	N/A	0	0	N/A	103	10	10
MEAN D2	0			15			99		
STD DEV	0			11			11		
RSD	N/A			74			12		
D31W	0	0	N/A	0	0	N/A	80	10	13
D32W	48	28	58	18	12	67	90	10	11
D33W	0	0	N/A	20	12	60	77	9	12
MEAN D3	16			13			82		
STD DEV	23			9			6		
RSD	141			71			7		
D41W	0	0	N/A	0	0	N/A	60	8	13
D42W	0	0	N/A	33	12	36	42	7	17
D43W	0	0	N/A	0	0	N/A	48	8	17
MEAN D4	0			11			50		
STD DEV	0			16			7		
RSD	N/A			141			15		
D51W	0	0	N/A	0	0	N/A	52	8	15
D52W	63	26	41	0	0	N/A	42	7	17
D53W	0	0	N/A	0	0	N/A	67	8	12
MEAN D5	21			0			54		
STD DEV	30			0			10		
RSD	141			N/A			19		

STATION (Sample)	Hg ppm	Hg Std Dev	Hg RSD	Pb ppm	Pb Std Dev	Pb RSD	Rb ppm	Rb Std Dev	Rb RSD
E11W	0	0	N/A	20	12	60	70	9	13
E12W	0	0	N/A	33	12	36	67	9	13
E13W	27	27	100	50	13	26	83	9	11
MEAN E1	9			34			73		
STD DEV	13			12			7		
RSD	141			36			9		
E21W	0	0	N/A	31	13	42	91	10	11
E22W	0	0	N/A	14	12	86	74	9	12
E23W	0	0	N/A	29	13	45	97	10	10
MEAN E2	0			25			87		
STD DEV	0			8			10		
RSD	N/A			31			11		
E31W	0	0	N/A	21	12	57	76	9	12
E32W	0	0	N/A	0	0	N/A	83	9	11
E33W	0	0	N/A	0	0	N/A	94	9	10
MEAN E3	0			7			84		
STD DEV	0			10			7		
RSD	N/A			141			9		
E41W	0	0	N/A	27	12	44	96	10	10
E42W	0	0	N/A	0	0	N/A	74	9	12
E43W	0	0	N/A	0	0	N/A	89	9	10
MEAN E4	0			9			87		
STD DEV	0			13			10		
RSD	N/A			141			11		
E51W	0	0	N/A	0	0	N/A	51	8	16
E52W	0	0	N/A	15	11	73	52	8	15
E53W	0	0	N/A	0	0	N/A	59	8	14
MEAN E5	0			5			54		
STD DEV	0			7			4		
RSD	N/A			141			7		

STATION (Sample)	Hg ppm	Hg Std Dev	Hg RSD	Pb ppm	Pb Std Dev	Pb RSD	Rb ppm	Rb Std Dev	Rb RSD
F11W	0	0	N/A	27	12	44	70	8	11
F12W	0	0	N/A	25	11	44	77	8	10
F13W	0	0	N/A	30	12	40	67	8	12
MEAN F1	0			27			71		
STD DEV	0			2			4		
RSD	N/A			8			6		
F21W	0	0	N/A	12	10	83	43	7	16
F22W	0	0	N/A	0	0	N/A	63	8	13
F23W	0	0	N/A	14	11	79	55	8	15
MEAN F2	0			9			54		
STD DEV	0			6			8		
RSD	N/A			71			15		
F31W	0	0	N/A	0	0	N/A	59	8	14
F32W	0	0	N/A	0	0	N/A	55	8	15
F33W	0	0	N/A	0	0	N/A	47	8	17
MEAN F3	0			0			54		
STD DEV	0			0			5		
RSD	N/A			N/A			9		
F41W	0	0	N/A	10	10	100	48	7	15
F42W	0	0	N/A	0	0	N/A	53	7	13
F43W	0	0	N/A	0	0	N/A	47	7	15
MEAN F4	0			3			49		
STD DEV	0			5			3		
RSD	N/A			141			5		
F51W	0	0	N/A	12	11	92	49	8	16
F52W	0	0	N/A	0	0	N/A	60	8	13
F53W	0	0	N/A	27	11	41	61	8	13
MEAN F5	0			13			57		
STD DEV	0			11			5		
RSD	N/A			85			10		

STATION (Sample)	Cd ppm	Cd Std Dev	Cd RSD	Ba ppm	Ba Std Dev	Ba RSD	Ag ppm	Ag Std Dev	Ag RSD
D11W	124	44	35	175	8	5	28	27	96
D12W	0	0	N/A	142	7	5	150	27	18
D13W	44	41	93	141	7	5	83	26	31
MEAN D1	56			153			87		
STD DEV	51			16			50		
RSD	92			10			57		
D21W	0	0	N/A	170	8	5	86	26	30
D22W	0	0	N/A	184	8	4	73	28	38
D23W	0	0	N/A	183	8	4	73	28	38
MEAN D2	0			179			77		
STD DEV	0			6			6		
RSD	N/A			4			8		
D31W	57	46	81	266	9	3	0	0	N/A
D32W	0	0	N/A	235	9	4	79	29	37
D33W	0	0	N/A	243	9	4	72	28	39
MEAN D3	19			248			50		
STD DEV	27			13			36		
RSD	141			5			71		
D41W	118	43	36	331	10	3	57	27	47
D42W	77	42	55	342	10	3	67	27	40
D43W	0	0	N/A	338	10	3	54	27	50
MEAN D4	65			337			59		
STD DEV	49			5			6		
RSD	75			1			9		
D51W	0	0	N/A	336	10	3	69	26	38
D52W	0	0	N/A	360	10	3	0	0	N/A
D53W	0	0	N/A	362	10	3	59	26	44
MEAN D5	0			353			43		
STD DEV	0			12			30		
RSD	N/A			3			71		

STATION (Sample)	Cd ppm	Cd Std Dev	Cd RSD	Ba ppm	Ba Std Dev	Ba RSD	Ag ppm	Ag Std Dev	Ag RSD
E11W	0	0	N/A	237	9	4	52	27	52
E12W	0	0	N/A	224	8	4	78	27	35
E13W	0	0	N/A	212	8	4	103	27	26
MEAN E1	0			224			78		
STD DEV	0			10			21		
RSD	N/A			5			27		
E21W	0	0	N/A	190	8	4	110	28	25
E22W	0	0	N/A	172	8	5	35	27	77
E23W	0	0	N/A	172	8	5	47	27	57
MEAN E2	0			178			64		
STD DEV	0			8			33		
RSD	N/A			5			51		
E31W	0	0	N/A	215	8	4	42	26	62
E32W	0	0	N/A	257	9	4	66	27	41
E33W	0	0	N/A	212	8	4	88	27	31
MEAN E3	0			228			65		
STD DEV	0			21			19		
RSD	N/A			9			29		
E41W	0	0	N/A	182	8	4	0	0	N/A
E42W	54	42	78	162	7	4	68	26	38
E43W	0	0	N/A	174	8	5	80	27	34
MEAN E4	18			173			49		
STD DEV	25			8			35		
RSD	141			5			71		
E51W	0	0	N/A	293	9	3	81	26	32
E52W	64	41	64	291	9	3	53	26	49
E53W	0	0	N/A	307	9	3	88	26	30
MEAN E5	21			297			74		
STD DEV	30			7			15		
RSD	141			2			20		

STATION (Sample)	Cd ppm	Cd Std Dev	Cd RSD	Ba ppm	Ba Std Dev	Ba RSD	Ag ppm	Ag Std Dev	Ag RSD
F11W	0	0	N/A	358	10	3	31	27	87
F12W	0	0	N/A	306	9	3	120	26	22
F13W	79	41	52	329	10	3	112	27	24
MEAN F1	26			331			88		
STD DEV	37			21			40		
RSD	141			6			46		
F21W	0	0	N/A	339	10	3	60	25	42
F22W	0	0	N/A	350	10	3	130	26	20
F23W	55	41	75	362	10	3	0	0	N/A
MEAN F2	18			350			63		
STD DEV	26			9			53		
RSD	141			3			84		
F31W	0	0	N/A	324	9	3	101	25	25
F32W	0	0	N/A	329	9	3	33	25	76
F33W	78	41	53	361	10	3	72	26	36
MEAN F3	26			338			69		
STD DEV	37			16			28		
RSD	141			5			41		
F41W	0	0	N/A	299	9	3	97	25	26
F42W	0	0	N/A	319	9	3	80	25	31
F43W	0	0	N/A	350	10	3	58	25	43
MEAN F4	0			323			78		
STD DEV	0			21			16		
RSD	N/A			7			20		
F51W	51	41	80	356	10	3	53	26	49
F52W	0	0	N/A	323	10	3	69	26	38
F53W	84	41	49	343	10	3	35	26	74
MEAN F5	45			341			52		
STD DEV	35			14			14		
RSD	77			4			27		

STATION (Sample)	U ppm	U Std Dev	U RSD	Th ppm	Th Std Dev	Th RSD	Sb ppm	Sb Std Dev	Sb RSD
D11W	0	0	N/A	10	4	40	0	0	N/A
D12W	0	0	N/A	0	0	N/A	14	14	100
D13W	0	0	N/A	8	4	50	0	0	N/A
MEAN D1	0			6			5		
STD DEV	0			4			7		
RSD	N/A			72			141		
D21W	11	7	64	6	4	67	0	0	N/A
D22W	0	0	N/A	19	4	21	0	0	N/A
D23W	8	7	88	8	4	50	0	0	N/A
MEAN D2	6			11			0		
STD DEV	5			6			0		
RSD	73			52			N/A		
D31W	0	0	N/A	10	4	40	0	0	N/A
D32W	0	0	N/A	12	4	33	0	0	N/A
D33W	0	0	N/A	12	4	33	0	0	N/A
MEAN D3	0			11			0		
STD DEV	0			1			0		
RSD	N/A			8			N/A		
D41W	0	0	N/A	9	4	44	0	0	N/A
D42W	0	0	N/A	9	4	44	0	0	N/A
D43W	0	0	N/A	12	4	33	0	0	N/A
MEAN D4	0			10			0		
STD DEV	0			1			0		
RSD	N/A			14			N/A		
D51W	9	6	67	9	4	44	0	0	N/A
D52W	8	6	75	10	4	40	0	0	N/A
D53W	0	0	N/A	11	4	36	0	0	N/A
MEAN D5	6			10			0		
STD DEV	4			1			0		
RSD	71			8			N/A		

STATION (Sample)	U ppm	U Std Dev	U RSD	Th ppm	Th Std Dev	Th RSD	Sb ppm	Sb Std Dev	Sb RSD
E11W	0	0	N/A	6	4	67	0	0	N/A
E12W	0	0	N/A	8	4	50	0	0	N/A
E13W	0	0	N/A	0	0	N/A	0	0	N/A
MEAN E1	0			5			0		
STD DEV	0			3			0		
RSD	N/A			73			N/A		
E21W	0	0	N/A	8	4	50	0	0	N/A
E22W	0	0	N/A	0	0	N/A	0	0	N/A
E23W	0	0	N/A	10	4	44	0	0	N/A
MEAN E2	0			6			0		
STD DEV	0			4			0		
RSD	N/A			72			N/A		
E31W	0	0	N/A	13	4	34	0	0	N/A
E32W	0	0	N/A	10	4	40	0	0	N/A
E33W	0	0	N/A	16	4	25	0	0	N/A
MEAN E3	0			13			0		
STD DEV	0			2			0		
RSD	N/A			19			N/A		
E41W	0	0	N/A	7	4	61	0	0	N/A
E42W	8	7	88	15	4	27	0	0	N/A
E43W	0	0	N/A	16	4	25	0	0	N/A
MEAN E4	3			13			0		
STD DEV	4			4			0		
RSD	141			32			N/A		
E51W	0	0	N/A	15	4	27	0	0	N/A
E52W	0	0	N/A	13	4	31	0	0	N/A
E53W	0	0	N/A	7	4	57	0	0	N/A
MEAN E5	0			12			0		
STD DEV	0			3			0		
RSD	N/A			29			N/A		

STATION (Sample)	U ppm	U Std Dev	U RSD	Th ppm	Th Std Dev	Th RSD	Sb ppm	Sb Std Dev	Sb RSD
F11W	0	0	N/A	10	4	40	0	0	N/A
F12W	0	0	N/A	14	4	29	0	0	N/A
F13W	0	0	N/A	9	4	44	0	0	N/A
MEAN F1	0			11			0		
STD DEV	0			2			0		
RSD	N/A			20			N/A		
F21W	0	0	N/A	9	4	44	0	0	N/A
F22W	0	0	N/A	7	4	57	0	0	N/A
F23W	0	0	N/A	6	4	67	0	0	N/A
MEAN F2	0			7			0		
STD DEV	0			1			0		
RSD	N/A			17			N/A		
F31W	0	0	N/A	0	0	N/A	0	0	N/A
F32W	0	0	N/A	10	4	40	0	0	N/A
F33W	10	6	60	0	0	N/A	0	0	N/A
MEAN F3	3			3			0		
STD DEV	5			5			0		
RSD	141			141			N/A		
F41W	0	0	N/A	0	0	N/A	0	0	N/A
F42W	0	0	N/A	16	4	25	0	0	N/A
F43W	0	0	N/A	12	4	33	0	0	N/A
MEAN F4	0			9			0		
STD DEV	0			7			0		
RSD	N/A			73			N/A		
F51W	9	6	67	10	4	40	0	0	N/A
F52W	11	7	64	5	4	80	0	0	N/A
F53W	0	0	N/A	0	0	N/A	0	0	N/A
MEAN F5	7			5			0		
STD DEV	5			4			0		
RSD	72			82			N/A		

STATION (Sample)	Sn ppm	Sn Std Dev	Sn RSD
D11W	0	0	N/A
D12W	0	0	N/A
D13W	0	0	N/A
MEAN D1	0		
STD DEV	0		
RSD	N/A		
D21W	0	0	N/A
D22W	0	0	N/A
D23W	0	0	N/A
MEAN D2	0		
STD DEV	0		
RSD	N/A		
D31W	0	0	N/A
D32W	0	0	N/A
D33W	0	0	N/A
MEAN D3	0		
STD DEV	0		
RSD	N/A		
D41W	0	0	N/A
D42W	0	0	N/A
D43W	0	0	N/A
MEAN D4	0		
STD DEV	0		
RSD	N/A		
D51W	0	0	N/A
D52W	0	0	N/A
D53W	0	0	N/A
MEAN D5	0		
STD DEV	0		
RSD	N/A		

STATION (Sample)	Sn ppm	Sn Std Dev	Sn RSD
E11W	0	0	N/A
E12W	0	0	N/A
E13W	0	0	N/A
MEAN E1	0		
STD DEV	0		
RSD	N/A		
E21W	0	0	N/A
E22W	0	0	N/A
E23W	0	0	N/A
MEAN E2	0		
STD DEV	0		
RSD	N/A		
E31W	0	0	N/A
E32W	0	0	N/A
E33W	0	0	N/A
MEAN E3	0		
STD DEV	0		
RSD	N/A		
E41W	0	0	N/A
E42W	0	0	N/A
E43W	0	0	N/A
MEAN E4	0		
STD DEV	0		
RSD	N/A		
E51W	0	0	N/A
E52W	0	0	N/A
E53W	0	0	N/A
MEAN E5	0		
STD DEV	0		
RSD	N/A		

STATION (Sample)	Sn ppm	Sn Std Dev	Sn RSD
F11W	0	0	N/A
F12W	0	0	N/A
F13W	0	0	N/A
MEAN F1	0		
STD DEV	0		
RSD	N/A		
F21W	0	0	N/A
F22W	0	0	N/A
F23W	16	11	69
MEAN F2	5		
STD DEV	8		
RSD	141		
F31W	0	0	N/A
F32W	0	0	N/A
F33W	15	11	73
MEAN F3	5		
STD DEV	7		
RSD	141		
F41W	0	0	N/A
F42W	0	0	N/A
F43W	0	0	N/A
MEAN F4	0		
STD DEV	0		
RSD	N/A		
F51W	0	0	N/A
F52W	0	0	N/A
F53W	0	0	N/A
MEAN F5	0		
STD DEV	0		
RSD	N/A		

XRF FIELD TEST---LAB TRIALS---JULY 13, 1993 DRY GROUND SAMPLES

STATION (Sample)	Cr ppm	Cr Std Dev	Cr RSD	K ppm	K Std Dev	K RSD	Ca ppm	Ca Std Dev	Ca RSD
A11D	0	0	N/A	20576	830	4	18419	524	3
A12D	0	0	N/A	22150	857	4	17762	518	3
A13D	0	0	N/A	20513	830	4	19424	536	3
MEAN A1	0			21080			18535		
STD DEV	0			757			683		
RSD	N/A			4			4		
A21D	0	0	N/A	22563	861	4	11996	441	4
A22D	0	0	N/A	21863	848	4	12321	444	4
A23D	0	0	N/A	21392	840	4	11453	430	4
MEAN A2	0			21939			11923		
STD DEV	0			481			358		
RSD	N/A			2			3		
A31D	0	0	N/A	21144	843	4	21477	562	3
A32D	0	0	N/A	22624	868	4	21439	564	3
A33D	0	0	N/A	21608	850	4	20997	557	3
MEAN A3	0			21792			21304		
STD DEV	0			618			218		
RSD	N/A			3			1		
A41D	0	0	N/A	19807	819	4	21180	556	3
A42D	0	0	N/A	18023	788	4	22129	564	3
A43D	0	0	N/A	17993	787	4	21447	556	3
MEAN A4	0			18608			21585		
STD DEV	0			848			400		
RSD	N/A			5			2		
A51D	0	0	N/A	15622	745	5	25264	593	2
A52D	0	0	N/A	15023	736	5	26960	611	2
A53D	0	0	N/A	14692	729	5	27165	612	2
MEAN A5	0			15112			26463		
STD DEV	0			385			852		
RSD	N/A			3			3		

XRF FIELD TEST---LAB TRIALS---JULY 13, 1993 DRY GROUND SAMPLES

STATION (Sample)	Cr ppm	Cr Std Dev	Cr RSD	K ppm	K Std Dev	K RSD	Ca ppm	Ca Std Dev	Ca RSD
B11D	0	0	N/A	23149	871	4	12460	448	4
B12D	0	0	N/A	24969	900	4	12499	453	4
B13D	0	0	N/A	23154	871	4	12464	448	4
MEAN B1	0			23757			12474		
STD DEV	0			857			18		
RSD	N/A			4			0		
B21D	0	0	N/A	19898	831	4	33218	682	2
B22D	0	0	N/A	20240	840	4	38834	734	2
B23D	0	0	N/A	19106	815	4	31331	333	1
MEAN B2	0			19748			34461		
STD DEV	0			475			3187		
RSD	N/A			2			9		
B31D	0	0	N/A	22738	864	4	13640	464	3
B32D	0	0	N/A	20814	470	2	14233	470	3
B33D	0	0	N/A	21365	841	4	13315	458	3
MEAN B3	0			21639			13729		
STD DEV	0			809			380		
RSD	N/A			4			3		
B41D	0	0	N/A	19505	811	4	17842	514	3
B42D	0	0	N/A	20759	832	4	16671	502	3
B43D	0	0	N/A	18956	803	4	18857	537	3
MEAN B4	0			19740			17790		
STD DEV	0			755			893		
RSD	N/A			4			5		
B51D	0	0	N/A	15133	740	5	28572	630	2
B52D	0	0	N/A	18172	797	4	29294	640	2
B53D	0	0	N/A	17332	782	5	30125	648	2
MEAN B5	0			16879			29330		
STD DEV	0			1281			635		
RSD	N/A			8			2		

XRF FIELD TEST---LAB TRIALS---JULY 13, 1993 DRY GROUND SAMPLES

STATION (Sample)	Cr ppm	Cr Std Dev	Cr RSD	K ppm	K Std Dev	K RSD	Ca ppm	Ca Std Dev	Ca RSD
C11D	0	0	N/A	20298	826	4	18063	519	3
C12D	0	0	N/A	21225	841	4	16441	500	3
C13D	0	0	N/A	20457	828	4	17589	513	3
MEAN C1	0			20660			17364		
STD DEV	0			405			681		
RSD	N/A			2			4		
C21D	0	0	N/A	17762	813	5	61064	902	1
C22D	0	0	N/A	17934	817	5	62526	913	1
C23D	0	0	N/A	17467	810	5	64627	926	1
MEAN C2	0			17721			62739		
STD DEV	0			193			1462		
RSD	N/A			1			2		
C31D	0	0	N/A	21330	844	4	19073	534	3
C32D	0	0	N/A	21067	840	4	19276	536	3
C33D	0	0	N/A	22550	864	4	17685	518	3
MEAN C3	0			21649			18678		
STD DEV	0			646			707		
RSD	N/A			3			4		
C41D	0	0	N/A	22845	868	4	16006	497	3
C42D	0	0	N/A	22466	862	4	17074	510	3
C43D	0	0	N/A	23090	872	4	16114	499	3
MEAN C4	0			22800			16398		
STD DEV	0			257			480		
RSD	N/A			1			3		
C51D	0	0	N/A	17805	786	4	25120	596	2
C52D	0	0	N/A	17711	786	4	25890	605	2
C53D	0	0	N/A	17482	781	4	25105	596	2
MEAN C5	0			17666			25372		
STD DEV	0			136			367		
RSD	N/A			1			1		

STATION (Sample)	Ti ppm	Ti Std Dev	Ti RSD	Mn ppm	Mn Std Dev	Mn RSD	Fe ppm	Fe Std Dev	Fe RSD
A11D	2998	245	8	623	192	31	28864	523	2
A12D	3387	249	7	1243	222	18	29518	531	2
A13D	3393	250	7	546	191	35	29335	529	2
MEAN A1	3259			804			29239		
STD DEV	185			312			275		
RSD	6			39			1		
A21D	4138	273	7	971	214	22	42431	640	2
A22D	4307	275	6	771	203	26	42584	641	2
A23D	4072	268	7	328	185	56	40915	626	2
MEAN A2	4172			690			41977		
STD DEV	99			269			753		
RSD	2			39			2		
A31D	3123	250	8	619	196	32	34869	581	2
A32D	3756	264	7	579	196	34	35947	450	1
A33D	3974	254	6	697	204	29	35376	587	2
MEAN A3	3618			632			35397		
STD DEV	361			49			440		
RSD	10			8			1		
A41D	2910	230	8	622	185	30	25452	490	2
A42D	2373	228	10	685	186	27	26016	495	2
A43D	3014	232	8	535	182	34	25449	489	2
MEAN A4	2766			614			25639		
STD DEV	281			61			267		
RSD	10			10			1		
A51D	1962	201	10	375	163	43	19120	422	2
A52D	2038	206	10	629	177	28	19525	427	2
A53D	1994	197	10	805	183	23	19122	421	2
MEAN A5	1998			603			19256		
STD DEV	31			177			190		
RSD	2			29			1		

STATION (Sample)	Ti ppm	Ti Std Dev	Ti RSD	Mn ppm	Mn Std Dev	Mn RSD	Fe ppm	Fe Std Dev	Fe RSD
B11D	4037	278	7	698	206	30	49957	670	1
B12D	4504	280	6	494	203	41	50796	710	1
B13D	3681	280	8	642	205	32	49107	694	1
MEAN B1	4074			611			49953		
STD DEV	337			86			690		
RSD	8			14			1		
B21D	3864	271	7	1056	220	21	37395	610	2
B22D	3700	265	7	797	211	26	36605	606	2
B23D	3419	261	8	602	196	33	35140	588	2
MEAN B2	3661			818			36380		
STD DEV	184			186			934		
RSD	5			23			3		
B31D	4213	263	6	888	213	24	43133	648	2
B32D	3818	266	7	678	199	29	42170	637	2
B33D	3736	271	7	1124	223	20	43482	648	1
MEAN B3	3922			897			42928		
STD DEV	208			182			555		
RSD	5			20			1		
B41D	3656	247	7	676	191	28	32975	559	2
B42D	3648	250	7	486	185	38	33732	567	2
B43D	3237	251	8	690	199	29	34590	574	2
MEAN B4	3514			617			33766		
STD DEV	196			93			660		
RSD	6			15			2		
B51D	2460	221	9	612	177	29	24081	476	2
B52D	1997	222	11	568	177	31	21935	456	2
B53D	2418	220	9	482	176	37	22664	465	2
MEAN B5	2292			554			22893		
STD DEV	209			54			891		
RSD	9			10			4		

STATION (Sample)	Ti ppm	Ti Std Dev	Ti RSD	Mn ppm	Mn Std Dev	Mn RSD	Fe ppm	Fe Std Dev	Fe RSD
C11D	3480	260	7	878	208	24	38052	605	2
C12D	3916	265	7	908	210	23	37794	604	2
C13D	4141	264	6	879	209	24	37952	605	2
MEAN C1	3846			888			37933		
STD DEV	274			14			106		
RSD	7			2			0		
C21D	4206	267	6	1921	258	13	33324	589	2
C22D	3297	265	8	1177	226	19	33854	593	2
C23D	3414	265	8	1369	238	17	33151	588	2
MEAN C2	3639			1489			33443		
STD DEV	404			315			299		
RSD	11			21			1		
C31D	3974	271	7	722	209	29	45393	668	1
C32D	4413	276	6	1012	222	22	45448	577	1
C33D	4148	272	7	1116	226	20	45015	665	1
MEAN C3	4178			950			45285		
STD DEV	180			167			192		
RSD	4			18			0		
C41D	4070	273	7	930	221	24	47971	688	1
C42D	4250	278	7	1254	232	19	47736	687	1
C43D	4575	284	6	990	225	23	46383	678	1
MEAN C4	4298			1058			47363		
STD DEV	209			141			700		
RSD	5			13			1		
C51D	3046	224	7	760	189	25	23381	470	2
C52D	2648	222	8	745	192	26	22334	460	2
C53D	2674	223	8	578	178	31	21837	453	2
MEAN C5	2789			694			22517		
STD DEV	182			82			644		
RSD	7			12			3		

STATION (Sample)	Co ppm	Co Std Dev	Co RSD	Ni ppm	Ni Std Dev	NI RSD	Cu ppm	Cu Std Dev	Cu RSD
A11D	530	182	34	0	0	N/A	32	30	94
A12D	291	180	62	0	0	N/A	0	0	N/A
A13D	0	0	N/A	106	54	51	0	0	N/A
MEAN A1	274			35			11		
STD DEV	217			50			15		
RSD	79			141			141		
A21D	0	0	N/A	0	0	N/A	53	33	62
A22D	0	0	N/A	0	0	N/A	138	37	27
A23D	297	205	69	0	0	N/A	34	31	91
MEAN A2	99			0			75		
STD DEV	140			0			45		
RSD	141			N/A			60		
A31D	0	0	N/A	0	0	N/A	81	34	42
A32D	493	200	41	0	0	N/A	73	33	45
A33D	0	0	N/A	0	0	N/A	90	34	38
MEAN A3	164			0			81		
STD DEV	232			0			7		
RSD	141			N/A			9		
A41D	0	0	N/A	0	0	N/A	0	0	N/A
A42D	0	0	N/A	0	0	N/A	89	32	36
A43D	0	0	N/A	58	51	88	90	32	36
MEAN A4	0			19			60		
STD DEV	0			27			42		
RSD	N/A			141			71		
A51D	0	0	N/A	85	49	58	0	0	N/A
A52D	0	0	N/A	0	0	N/A	0	0	N/A
A53D	0	0	N/A	0	0	N/A	0	0	N/A
MEAN A5	0			28			0		
STD DEV	0			40			0		
RSD	N/A			141			N/A		

STATION (Sample)	Co ppm	Co Std Dev	Co RSD	Ni ppm	Ni Std Dev	Ni RSD	Cu ppm	Cu Std Dev	Cu RSD
B11D	0	0	N/A	0	0	N/A	368	48	13
B12D	0	0	N/A	0	0	N/A	390	49	13
B13D	507	227	45	0	0	N/A	334	47	14
MEAN B1	169			0			364		
STD DEV	239			0			23		
RSD	141			N/A			6		
B21D	0	0	N/A	0	0	N/A	43	32	74
B22D	0	0	N/A	0	0	N/A	92	35	38
B23D	0	0	N/A	0	0	N/A	71	33	46
MEAN B2	0			0			69		
STD DEV	0			0			20		
RSD	N/A			N/A			29		
B31D	0	0	N/A	0	0	N/A	138	37	27
B32D	424	211	50	0	0	N/A	132	36	27
B33D	0	0	N/A	0	0	N/A	126	36	29
MEAN B3	141			0			132		
STD DEV	200			0			5		
RSD	141			N/A			4		
B41D	0	0	N/A	66	54	82	54	32	59
B42D	0	0	N/A	166	59	36	51	32	63
B43D	0	0	N/A	0	0	N/A	92	34	37
MEAN B4	0			77			66		
STD DEV	0			68			19		
RSD	N/A			88			28		
B51D	0	0	N/A	0	0	N/A	72	31	43
B52D	0	0	N/A	0	0	N/A	0	0	N/A
B53D	0	0	N/A	55	50	91	0	0	N/A
MEAN B5	0			18			24		
STD DEV	0			26			34		
RSD	N/A			141			141		

STATION (Sample)	Co ppm	Co Std Dev	Co RSD	Ni ppm	Ni Std Dev	Ni RSD	Cu ppm	Cu Std Dev	Cu RSD
C11D	0	0	N/A	0	0	N/A	117	36	31
C12D	412	202	49	0	0	N/A	173	38	22
C13D	0	0	N/A	0	0	N/A	118	36	31
MEAN C1	137			0			136		
STD DEV	194			0			26		
RSD	141			N/A			19		
C21D	0	0	N/A	0	0	N/A	0	0	N/A
C22D	0	0	N/A	0	0	N/A	0	0	N/A
C23D	0	0	N/A	0	0	N/A	0	0	N/A
MEAN C2	0			0			0		
STD DEV	0			0			0		
RSD	N/A			N/A			N/A		
C31D	0	0	N/A	102	60	59	111	36	32
C32D	489	221	45	0	0	N/A	0	0	N/A
C33D	0	0	N/A	0	0	N/A	41	32	78
MEAN C3	163			34			51		
STD DEV	231			48			46		
RSD	141			141			90		
C41D	0	0	N/A	81	60	74	71	35	49
C42D	496	226	46	0	0	N/A	66	34	52
C43D	348	221	64	0	0	N/A	143	38	27
MEAN C4	281			27			93		
STD DEV	208			38			35		
RSD	74			141			38		
C51D	0	0	N/A	79	51	65	0	0	N/A
C52D	162	157	97	0	0	N/A	61	31	51
C53D	0	0	N/A	0	0	N/A	0	0	N/A
MEAN C5	54			26			20		
STD DEV	76			37			29		
RSD	141			141			141		

STATION (Sample)	Zn ppm	Zn Std Dev	Zn RSD	As ppm	As Std Dev	As RSD	Se ppm	Se Std Dev	Se RSD
A11D	121	28	23	23	18	78	0	0	N/A
A12D	172	30	17	26	18	69	0	0	N/A
A13D	158	30	19	44	19	43	0	0	N/A
MEAN A1	150			31			0		
STD DEV	22			9			0		
RSD	14			30			N/A		
A21D	284	35	12	73	23	32	0	0	N/A
A22D	272	35	13	51	23	45	0	0	N/A
A23D	215	32	15	55	22	40	0	0	N/A
MEAN A2	257			60			0		
STD DEV	30			10			0		
RSD	12			16			N/A		
A31D	197	32	16	38	19	50	19	11	58
A32D	175	31	18	58	18	31	19	11	61
A33D	156	30	19	0	0	N/A	0	0	N/A
MEAN A3	176			32			13		
STD DEV	17			24			9		
RSD	10			75			71		
A41D	117	28	24	25	16	64	0	0	N/A
A42D	59	25	42	46	17	37	0	0	N/A
A43D	138	29	21	0	0	N/A	13	10	77
MEAN A4	105			24			4		
STD DEV	33			19			6		
RSD	32			79			141		
A51D	165	28	17	26	15	58	0	0	N/A
A52D	72	25	35	17	15	88	0	0	N/A
A53D	148	28	19	48	16	33	0	0	N/A
MEAN A5	128			30			0		
STD DEV	40			13			0		
RSD	32			43			N/A		

STATION (Sample)	Zn ppm	Zn Std Dev	Zn RSD	As ppm	As Std Dev	As RSD	Se ppm	Se Std Dev	Se RSD
B11D	424	41	10	81	24	30	0	0	N/A
B12D	533	44	8	62	22	35	0	0	N/A
B13D	417	40	10	53	21	40	13	11	85
MEAN B1	458			65			4		
STD DEV	53			12			6		
RSD	12			18			141		
B21D	117	29	25	0	0	N/A	0	0	N/A
B22D	189	32	17	39	18	46	22	11	51
B23D	98	28	29	24	17	71	0	0	N/A
MEAN B2	135			21			7		
STD DEV	39			16			10		
RSD	29			76			141		
B31D	334	37	11	43	20	47	0	0	N/A
B32D	330	36	11	0	0	N/A	0	0	N/A
B33D	223	33	15	40	33	83	20	11	55
MEAN B3	296			28			7		
STD DEV	51			20			9		
RSD	17			71			141		
B41D	186	31	17	34	18	53	0	0	N/A
B42D	222	32	14	52	18	35	23	11	48
B43D	98	28	29	58	18	31	0	0	N/A
MEAN B4	169			48			8		
STD DEV	52			10			11		
RSD	31			21			141		
B51D	75	26	35	0	0	N/A	0	0	N/A
B52D	122	28	23	30	16	53	17	10	59
B53D	113	28	25	48	17	35	0	0	N/A
MEAN B5	103			26			6		
STD DEV	20			20			8		
RSD	20			76			141		

STATION (Sample)	Zn ppm	Zn Std Dev	Zn RSD	As ppm	As Std Dev	As RSD	Se ppm	Se Std Dev	Se RSD
C11D	325	36	11	63	21	33	0	0	N/A
C12D	367	38	10	0	0	N/A	0	0	N/A
C13D	321	36	11	26	21	81	0	0	N/A
MEAN C1	338			30			0		
STD DEV	21			26			0		
RSD	6			87			N/A		
C21D	46	27	59	32	16	50	0	0	N/A
C22D	33	26	79	30	16	53	0	0	N/A
C23D	54	27	50	0	0	N/A	0	0	N/A
MEAN C2	44			21			0		
STD DEV	9			15			0		
RSD	20			71			N/A		
C31D	209	33	16	22	17	77	0	0	N/A
C32D	186	32	17	33	18	55	0	0	N/A
C33D	216	33	15	26	17	65	0	0	N/A
MEAN C3	204			27			0		
STD DEV	13			5			0		
RSD	6			17			N/A		
C41D	216	33	15	32	20	63	0	0	N/A
C42D	173	32	18	44	20	45	0	0	N/A
C43D	242	34	14	83	0	21	0	0	N/A
MEAN C4	210			53			0		
STD DEV	28			22			0		
RSD	14			41			N/A		
C51D	90	27	30	20	17	85	17	10	59
C52D	112	28	25	41	17	41	0	0	N/A
C53D	105	27	26	36	15	42	0	0	N/A
MEAN C5	102			32			6		
STD DEV	9			9			8		
RSD	9			28			141		

STATION (Sample)	Sr ppm	Sr Std Dev	Sr RSD	Zr ppm	Zr Std Dev	Zr RSD	Mo ppm	Mo Std Dev	Mo RSD
A11D	236	10	4	265	7	3	3	2	67
A12D	244	10	4	296	7	2	3	3	87
A13D	241	10	4	277	7	3	6	3	50
MEAN A1	240			279			4		
STD DEV	3			13			1		
RSD	1			5			34		
A21D	167	9	5	183	6	3	8	3	38
A22D	172	9	5	199	6	3	0	0	N/A
A23D	159	8	5	202	6	3	9	3	33
MEAN A2	166			195			6		
STD DEV	5			8			4		
RSD	3			4			71		
A31D	229	10	4	137	6	4	0	0	N/A
A32D	248	10	4	158	6	4	0	0	N/A
A33D	230	10	4	183	6	3	6	3	50
MEAN A3	236			159			2		
STD DEV	9			19			3		
RSD	4			12			141		
A41D	243	10	4	178	6	3	4	2	50
A42D	250	10	4	144	6	4	4	2	50
A43D	263	10	4	181	6	3	0	0	N/A
MEAN A4	252			168			3		
STD DEV	8			17			2		
RSD	3			10			71		
A51D	248	10	4	139	5	4	5	2	40
A52D	264	10	4	132	5	4	0	0	N/A
A53D	255	10	4	135	5	4	5	2	40
MEAN A5	256			135			3		
STD DEV	7			3			2		
RSD	3			2			71		

STATION (Sample)	Sr ppm	Sr Std Dev	Sr RSD	Zr ppm	Zr Std Dev	Zr RSD	Mo ppm	Mo Std Dev	Mo RSD
B11D	168	9	5	107	5	5	4	3	75
B12D	168	9	5	120	5	4	10	3	30
B13D	158	11	7	117	9	8	6	3	50
MEAN B1	165			115			7		
STD DEV	5			6			2		
RSD	3			5			37		
B21D	282	11	4	113	5	4	4	2	50
B22D	299	12	4	129	6	5	7	3	43
B23D	283	11	4	128	6	5	3	2	67
MEAN B2	288			123			5		
STD DEV	8			7			2		
RSD	3			6			36		
B31D	159	9	6	133	6	5	8	3	38
B32D	162	9	6	119	5	4	0	0	N/A
B33D	156	8	5	139	6	4	7	3	43
MEAN B3	159			130			5		
STD DEV	2			8			4		
RSD	2			6			71		
B41D	220	10	5	212	6	3	6	3	50
B42D	224	10	4	198	6	3	4	2	50
B43D	212	10	5	191	6	3	6	3	50
MEAN B4	219			200			5		
STD DEV	5			9			1		
RSD	2			4			18		
B51D	257	10	4	143	5	3	0	0	N/A
B52D	262	10	4	128	5	4	3	2	67
B53D	277	10	4	130	5	4	5	2	40
MEAN B5	265			134			3		
STD DEV	8			7			2		
RSD	3			5			77		

STATION (Sample)	Sr ppm	Sr Std Dev	Sr RSD	Zr ppm	Zr Std Dev	Zr RSD	Mo ppm	Mo Std Dev	Mo RSD
C11D	208	10	5	158	6	4	7	2	29
C12D	222	10	5	190	6	3	0	0	N/A
C13D	210	10	5	167	6	4	0	0	N/A
MEAN C1	213			172			2		
STD DEV	6			13			3		
RSD	3			8			141		
C21D	237	10	4	154	163	6	6	3	50
C22D	244	11	5	145	6	4	0	0	N/A
C23D	259	11	4	141	6	4	6	3	50
MEAN C2	247			147			4		
STD DEV	9			5			3		
RSD	4			4			71		
C31D	211	10	5	136	6	4	0	0	N/A
C32D	204	10	5	127	6	5	0	0	N/A
C33D	199	10	5	142	6	4	5	3	60
MEAN C3	205			135			2		
STD DEV	5			6			2		
RSD	2			5			141		
C41D	180	9	5	159	6	4	0	0	N/A
C42D	193	10	5	134	6	4	0	0	N/A
C43D	204	10	5	144	6	4	0	0	N/A
MEAN C4	192			146			0		
STD DEV	10			10			0		
RSD	5			7			N/A		
C51D	271	10	4	139	5	4	5	2	40
C52D	262	10	4	119	5	4	0	0	N/A
C53D	270	10	4	134	5	4	3	2	67
MEAN C5	268			131			3		
STD DEV	4			8			2		
RSD	2			7			77		

STATION (Sample)	Hg ppm	Hg Std Dev	Hg RSD	Pb ppm	Pb Std Dev	Pb RSD	Rb ppm	Rb Std Dev	Rb RSD
A11D	0	0	N/A	42	12	29	81	9	11
A12D	0	0	N/A	51	12	24	77	9	12
A13D	0	0	N/A	44	13	29	76	9	12
MEAN A1	0			46			78		
STD DEV	0			4			2		
RSD	N/A			8			3		
A21D	0	0	N/A	86	15	18	119	11	9
A22D	0	0	N/A	111	16	14	111	10	9
A23D	0	0	N/A	85	15	17	109	10	9
MEAN A2	0			94			113		
STD DEV	0			12			4		
RSD	N/A			13			4		
A31D	0	0	N/A	32	12	38	95	10	11
A32D	0	0	N/A	0	0	N/A	67	9	13
A33D	0	0	N/A	38	12	32	98	10	10
MEAN A3	0			23			87		
STD DEV	0			17			14		
RSD	N/A			71			16		
A41D	0	0	N/A	0	0	N/A	51	8	16
A42D	51	24	47	0	0	N/A	63	8	13
A43D	26	23	88	23	11	48	60	8	13
MEAN A4	26			8			58		
STD DEV	21			11			5		
RSD	81			141			9		
A51D	0	0	N/A	0	0	N/A	56	8	14
A52D	43	23	53	0	0	N/A	58	8	14
A53D	0	0	N/A	0	0	N/A	61	8	13
MEAN A5	14			0			58		
STD DEV	20			0			2		
RSD	141			N/A			4		

STATION (Sample)	Hg ppm	Hg Std Dev	Hg RSD	Pb ppm	Pb Std Dev	Pb RSD	Rb ppm	Rb Std Dev	Rb RSD
B11D	0	0	N/A	82	16	20	120	11	9
B12D	0	0	N/A	71	15	21	122	13	11
B13D	0	0	N/A	58	14	24	120	11	9
MEAN B1	0			70			121		
STD DEV	0			10			1		
RSD	N/A			14			1		
B21D	0	0	N/A	26	12	46	79	9	11
B22D	0	0	N/A	0	0	N/A	69	9	13
B23D	0	0	N/A	18	11	61	71	9	13
MEAN B2	0			15			73		
STD DEV	0			11			4		
RSD	N/A			74			6		
B31D	0	0	N/A	34	13	38	96	10	10
B32D	0	0	N/A	63	14	22	103	10	10
B33D	0	0	N/A	32	13	41	111	10	9
MEAN B3	0			43			103		
STD DEV	0			14			6		
RSD	N/A			33			6		
B41D	0	0	N/A	20	12	60	70	9	13
B42D	0	0	N/A	0	0	N/A	81	9	11
B43D	0	0	N/A	14	11	79	87	9	10
MEAN B4	0			11			79		
STD DEV	0			8			7		
RSD	N/A			74			9		
B51D	0	0	N/A	24	11	46	59	8	14
B52D	0	0	N/A	0	0	N/A	66	8	12
B53D	0	0	N/A	14	10	71	65	8	12
MEAN B5	0			13			63		
STD DEV	0			10			3		
RSD	N/A			78			5		

STATION (Sample)	Hg ppm	Hg Std Dev	Hg RSD	Pb ppm	Pb Std Dev	Pb RSD	Rb ppm	Rb Std Dev	Rb RSD
C11D	45	25	56	57	14	25	95	10	11
C12D	0	0	N/A	73	14	19	74	9	12
C13D	26	25	96	80	14	18	75	9	12
MEAN C1	24			70			81		
STD DEV	18			10			10		
RSD	78			14			12		
C21D	0	0	N/A	0	0	N/A	70	9	13
C22D	0	0	N/A	0	0	N/A	75	9	12
C23D	0	0	N/A	0	0	N/A	65	9	14
MEAN C2	0			0			70		
STD DEV	0			0			4		
RSD	N/A			N/A			6		
C31D	0	0	N/A	0	0	N/A	114	10	9
C32D	0	0	N/A	0	0	N/A	95	10	11
C33D	0	0	N/A	0	0	N/A	93	9	10
MEAN C3	0			0			101		
STD DEV	0			0			9		
RSD	N/A			N/A			9		
C41D	0	0	N/A	48	13	27	107	11	10
C42D	0	0	N/A	43	14	33	112	11	10
C43D	0	0	N/A	35	13	37	110	11	10
MEAN C4	0			42			110		
STD DEV	0			5			2		
RSD	N/A			13			2		
C51D	0	0	N/A	19	11	58	56	8	14
C52D	0	0	N/A	19	11	58	68	8	12
C53D	0	0	N/A	0	0	N/A	64	8	13
MEAN C5	0			13			63		
STD DEV	0			9			5		
RSD	N/A			71			8		

STATION (Sample)	Cd ppm	Cd Std Dev	Cd RSD	Ba ppm	Ba Std Dev	Ba RSD	Ag ppm	Ag Std Dev	Ag RSD
A11D	0	0	N/A	372	10	3	50	22	44
A12D	0	0	N/A	437	11	3	60	22	37
A13D	37	37	100	440	11	3	0	0	N/A
MEAN A1	12			416			37		
STD DEV	17			31			26		
RSD	141			8			72		
A21D	66	34	52	260	9	3	64	22	34
A22D	37	33	89	243	9	4	59	21	36
A23D	0	0	N/A	259	9	3	31	21	68
MEAN A2	34			254			51		
STD DEV	27			8			15		
RSD	79			3			28		
A31D	0	0	N/A	302	10	3	87	23	26
A32D	0	0	N/A	350	10	3	69	25	36
A33D	0	0	N/A	341	10	3	26	23	88
MEAN A3	0			331			61		
STD DEV	0			21			26		
RSD	N/A			6			42		
A41D	0	0	N/A	344	10	3	61	22	36
A42D	0	0	N/A	352	10	3	42	23	55
A43D	43	37	86	352	10	3	56	23	41
MEAN A4	14			349			53		
STD DEV	20			4			8		
RSD	141			1			15		
A51D	0	0	N/A	321	9	3	50	22	44
A52D	0	0	N/A	347	10	3	69	22	32
A53D	48	34	71	322	9	3	0	0	N/A
MEAN A5	16			330			40		
STD DEV	23			12			29		
RSD	141			4			73		

STATION (Sample)	Cd ppm	Cd Std Dev	Cd RSD	Ba ppm	Ba Std Dev	Ba RSD	Ag ppm	Ag Std Dev	Ag RSD
B11D	0	0	N/A	240	9	4	0	0	N/A
B12D	0	0	N/A	242	9	4	88	23	26
B13D	0	0	N/A	256	9	4	0	0	N/A
MEAN B1	0			246			29		
STD DEV	0			7			41		
RSD	N/A			3			141		
B21D	0	0	N/A	338	10	3	89	25	28
B22D	0	0	N/A	333	25	8	44	25	57
B23D	84	38	45	296	10	3	84	24	29
MEAN B2	28			322			72		
STD DEV	40			19			20		
RSD	141			6			28		
B31D	0	0	N/A	271	9	3	0	0	N/A
B32D	74	35	47	238	9	4	48	22	46
B33D	116	37	32	256	9	4	0	0	N/A
MEAN B3	63			255			16		
STD DEV	48			13			23		
RSD	76			5			141		
B41D	72	34	47	290	9	3	59	22	37
B42D	0	0	N/A	325	10	3	62	22	35
B43D	66	37	56	352	10	3	68	23	34
MEAN B4	46			322			63		
STD DEV	33			25			4		
RSD	71			8			6		
B51D	113	33	29	298	9	3	77	21	27
B52D	157	37	24	346	10	3	76	23	30
B53D	0	0	N/A	365	10	3	88	23	26
MEAN B5	90			336			80		
STD DEV	66			28			5		
RSD	73			8			7		

STATION (Sample)	Cd ppm	Cd Std Dev	Cd RSD	Ba ppm	Ba Std Dev	Ba RSD	Ag ppm	Ag Std Dev	Ag RSD
C11D	0	0	N/A	306	10	3	0	0	N/A
C12D	0	0	N/A	287	9	3	45	23	51
C13D	90	36	40	261	9	3	28	22	79
MEAN C1	30			285			24		
STD DEV	42			18			19		
RSD	141			6			76		
C21D	88	38	43	312	10	3	107	25	23
C22D	60	38	63	311	10	3	53	24	45
C23D	0	0	N/A	351	10	3	67	26	39
MEAN C2	49			325			76		
STD DEV	37			19			23		
RSD	74			6			30		
C31D	0	0	N/A	291	8	3	43	25	58
C32D	0	0	N/A	306	10	3	64	25	39
C33D	0	0	N/A	286	10	3	0	0	N/A
MEAN C3	0			294			36		
STD DEV	0			8			27		
RSD	N/A			3			75		
C41D	0	0	N/A	281	10	4	78	24	31
C42D	43	35	81	243	9	4	38	22	58
C43D	0	0	N/A	277	9	3	0	0	N/A
MEAN C4	14			267			39		
STD DEV	20			17			32		
RSD	141			6			82		
C51D	37	36	97	362	10	3	52	23	44
C52D	0	0	N/A	362	10	3	44	23	52
C53D	0	0	N/A	350	10	3	39	22	56
MEAN C5	12			358			45		
STD DEV	17			6			5		
RSD	141			2			12		

STATION (Sample)	U ppm	U Std Dev	U RSD	Th ppm	Th Std Dev	Th RSD	Sb ppm	Sb Std Dev	Sb RSD
A11D	0	0	N/A	7	4	57	15	12	80
A12D	0	0	N/A	5	4	80	25	13	52
A13D	7	6	86	15	4	27	0	0	N/A
MEAN A1	2			9			13		
STD DEV	3			4			10		
RSD	141			48			77		
A21D	0	0	N/A	16	4	25	0	0	N/A
A22D	0	0	N/A	5	4	80	17	14	86
A23D	0	0	N/A	23	4	17	0	0	N/A
MEAN A2	0			15			6		
STD DEV	0			7			8		
RSD	N/A			51			141		
A31D	0	0	N/A	9	4	44	20	13	65
A32D	0	0	N/A	18	4	24	0	0	N/A
A33D	0	0	N/A	0	0	N/A	0	0	N/A
MEAN A3	0			9			7		
STD DEV	0			7			9		
RSD	N/A			82			141		
A41D	0	0	N/A	4	4	100	0	0	N/A
A42D	0	0	N/A	13	4	31	0	0	N/A
A43D	0	0	N/A	0	0	N/A	0	0	N/A
MEAN A4	0			6			0		
STD DEV	0			5			0		
RSD	N/A			94			N/A		
A51D	0	0	N/A	8	4	50	0	0	N/A
A52D	0	0	N/A	0	0	N/A	34	13	38
A53D	0	0	N/A	10	4	42	0	0	N/A
MEAN A5	0			6			11		
STD DEV	0			4			16		
RSD	N/A			72			141		

STATION (Sample)	U ppm	U Std Dev	U RSD	Th ppm	Th Std Dev	Th RSD	Sb ppm	Sb Std Dev	Sb RSD
B11D	0	0	N/A	9	4	44	0	0	N/A
B12D	0	0	N/A	10	4	40	35	13	37
B13D	0	0	N/A	10	4	40	0	0	N/A
MEAN B1	0			10			12		
STD DEV	0			0			16		
RSD	N/A			5			141		
B21D	0	0	N/A	0	0	N/A	0	0	N/A
B22D	0	0	N/A	12	4	33	0	0	N/A
B23D	0	0	N/A	0	0	N/A	0	0	N/A
MEAN B2	0			4			0		
STD DEV	0			6			0		
RSD	N/A			141			N/A		
B31D	0	0	N/A	24	4	17	0	0	N/A
B32D	0	0	N/A	6	4	67	0	0	N/A
B33D	0	0	N/A	13	4	31	0	0	N/A
MEAN B3	0			14			0		
STD DEV	0			7			0		
RSD	N/A			52			N/A		
B41D	0	0	N/A	11	4	36	0	0	N/A
B42D	0	0	N/A	11	4	36	0	0	N/A
B43D	0	0	N/A	14	4	29	0	0	N/A
MEAN B4	0			12			0		
STD DEV	0			1			0		
RSD	N/A			12			N/A		
B51D	0	0	N/A	0	0	N/A	0	0	N/A
B52D	0	0	N/A	0	0	N/A	0	0	N/A
B53D	0	0	N/A	10	4	40	0	0	N/A
MEAN B5	0			3			0		
STD DEV	0			5			0		
RSD	N/A			141			N/A		

STATION (Sample)	U ppm	U Std Dev	U RSD	Th ppm	Th Std Dev	Th RSD	Sb ppm	Sb Std Dev	Sb RSD
C11D	0	0	N/A	12	4	33	37	14	38
C12D	0	0	N/A	11	4	36	0	0	N/A
C13D	0	0	N/A	6	4	67	0	0	N/A
MEAN C1	0			10			12		
STD DEV	0			3			17		
RSD	N/A			27			141		
C21D	0	0	N/A	6	4	67	0	0	N/A
C22D	0	0	N/A	5	4	80	0	0	N/A
C23D	0	0	N/A	6	4	67	0	0	N/A
MEAN C2	0			6			0		
STD DEV	0			0			0		
RSD	N/A			8			N/A		
C31D	0	0	N/A	6	4	67	18	14	78
C32D	0	0	N/A	23	4	17	14	14	100
C33D	0	0	N/A	12	4	33	0	0	N/A
MEAN C3	0			14			11		
STD DEV	0			7			8		
RSD	N/A			52			72		
C41D	0	0	N/A	4	4	100	0	0	N/A
C42D	0	0	N/A	9	4	44	16	13	81
C43D	0	0	N/A	7	4	57	27	14	52
MEAN C4	0			7			14		
STD DEV	0			2			11		
RSD	N/A			31			77		
C51D	0	0	N/A	12	4	33	0	0	N/A
C52D	0	0	N/A	7	4	57	23	14	61
C53D	0	0	N/A	11	4	36	19	13	68
MEAN C5	0			10			14		
STD DEV	0			2			10		
RSD	N/A			22			72		

STATION (Sample)	Sn ppm	Sn Std Dev	Sn RSD
A11D	0	0	N/A
A12D	0	0	N/A
A13D	10	10	100
MEAN A1	3		
STD DEV	5		
RSD	141		
A21D	12	10	83
A22D	0	0	N/A
A23D	0	0	N/A
MEAN A2	4		
STD DEV	6		
RSD	141		
A31D	0	0	N/A
A32D	0	0	N/A
A33D	12	11	92
MEAN A3	4		
STD DEV	6		
RSD	141		
A41D	0	0	N/A
A42D	0	0	N/A
A43D	13	10	77
MEAN A4	4		
STD DEV	6		
RSD	141		
A51D	14	10	71
A52D	0	0	N/A
A53D	0	0	N/A
MEAN A5	5		
STD DEV	7		
RSD	141		

STATION (Sample)	Sn ppm	Sn Std Dev	Sn RSD
B11D	22	10	45
B12D	0	0	N/A
B13D	22	10	45
MEAN B1	15		
STD DEV	10		
RSD	71		
B21D	0	0	N/A
B22D	0	0	N/A
B23D	0	0	N/A
MEAN B2	0		
STD DEV	0		
RSD	N/A		
B31D	20	10	50
B32D	13	10	77
B33D	18	10	56
MEAN B3	17		
STD DEV	3		
RSD	17		
B41D	0	0	N/A
B42D	0	0	N/A
B43D	0	0	N/A
MEAN B4	0		
STD DEV	0		
RSD	N/A		
B51D	0	0	N/A
B52D	0	0	N/A
B53D	0	0	N/A
MEAN B5	0		
STD DEV	0		
RSD	N/A		

STATION (Sample)	Sn ppm	Sn Std Dev	Sn RSD
C11D	0	0	N/A
C12D	0	0	N/A
C13D	23	10	43
MEAN C1	8		
STD DEV	11		
RSD	141		
C21D	0	0	N/A
C22D	0	0	N/A
C23D	0	0	N/A
MEAN C2	0		
STD DEV	0		
RSD	N/A		
C31D	0	0	N/A
C32D	0	0	N/A
C33D	12	11	92
MEAN C3	4		
STD DEV	6		
RSD	141		
C41D	24	11	46
C42D	22	10	45
C43D	0	0	N/A
MEAN C4	15		
STD DEV	11		
RSD	71		
C51D	0	0	N/A
C52D	14	11	79
C53D	0	0	N/A
MEAN C5	5		
STD DEV	7		
RSD	141		

XRF FIELD TEST---DRY GROUND SEDIMENTS---JULY 14, 1993---LABORATORY MEASUREMENTS

STATION (Sample)	Cr ppm	Cr Std Dev	Cr RSD	K ppm	K Std Dev	K RSD	Ca ppm	Ca Std Dev	Ca RSD
D11D	0	0	N/A	21709	848	4	14567	476	3
D12D	0	0	N/A	22900	868	4	14021	470	3
D13D	0	0	N/A	23377	876	4	14548	479	3
MEAN D1	0			22662			14379		
STD DEV	0			701			253		
RSD	N/A			3			2		
D21D	0	0	N/A	22011	854	4	16186	498	3
D22D	0	0	N/A	22842	868	4	16299	501	3
D23D	0	0	N/A	22089	856	4	16830	507	3
MEAN D2	0			22314			16438		
STD DEV	0			375			281		
RSD	N/A			2			2		
D31D	0	0	N/A	21658	164	1	19134	535	3
D32D	0	0	N/A	21922	855	4	19749	543	3
D33D	0	0	N/A	21359	844	4	18474	526	3
MEAN D3	0			21646			19119		
STD DEV	0			230			521		
RSD	N/A			1			3		
D41D	0	0	N/A	17299	784	5	33657	681	2
D42D	0	0	N/A	16439	769	5	33466	678	2
D43D	0	0	N/A	18166	798	4	30996	658	2
MEAN D4	0			17301			32706		
STD DEV	0			705			1212		
RSD	N/A			4			4		
D51D	0	0	N/A	18200	795	4	26542	612	2
D52D	0	0	N/A	17770	786	4	25038	596	2
D53D	0	0	N/A	15366	740	5	25109	592	2
MEAN D5	0			17112			25563		
STD DEV	0			1247			693		
RSD	N/A			7			3		

XRF FIELD TEST---DRY GROUND SEDIMENTS---JULY 14, 1993---LABORATORY MEASUREMENTS

STATION (Sample)	Cr ppm	Cr Std Dev	Cr RSD	K ppm	K Std Dev	K RSD	Ca ppm	Ca Std Dev	Ca RSD
E11D	0	0	N/A	20888	846	4	32026	673	2
E12D	0	0	N/A	21887	862	4	31251	667	2
E13D	0	0	N/A	19907	829	4	31705	668	2
MEAN E1	0			20894			31661		
STD DEV	0			808			318		
RSD	N/A			4			1		
E21D	0	0	N/A	22789	866	4	14229	473	3
E22D	0	0	N/A	23232	873	4	14062	472	3
E23D	0	0	N/A	23103	871	4	13577	465	3
MEAN E2	0			23041			13956		
STD DEV	0			186			277		
RSD	N/A			1			2		
E31D	0	0	N/A	21690	851	4	19836	543	3
E32D	0	0	N/A	20945	839	4	20843	554	3
E33D	0	0	N/A	21815	853	4	19897	545	3
MEAN E3	0			21483			20192		
STD DEV	0			384			461		
RSD	N/A			2			2		
E41D	0	0	N/A	23130	872	4	14321	475	3
E42D	0	0	N/A	23724	882	4	14986	485	3
E43D	0	0	N/A	22237	857	4	14729	479	3
MEAN E4	0			23030			14679		
STD DEV	0			611			274		
RSD	N/A			3			2		
E51D	0	0	N/A	18072	791	4	25212	598	2
E52D	0	0	N/A	19196	812	4	25771	606	2
E53D	0	0	N/A	18890	806	4	25522	603	2
MEAN E5	0			18719			25502		
STD DEV	0			474			229		
RSD	N/A			3			1		

XRF FIELD TEST---DRY GROUND SEDIMENTS---JULY 14, 1993---LABORATORY MEASUREMENTS

STATION (Sample)	Cr ppm	Cr Std Dev	Cr RSD	K ppm	K Std Dev	K RSD	Ca ppm	Ca Std Dev	Ca RSD
F11D	0	0	N/A	19595	813	4	18130	519	3
F12D	0	0	N/A	19513	812	4	19186	532	3
F13D	0	0	N/A	21939	854	4	18435	527	3
MEAN F1	0			20349			18584		
STD DEV	0			1125			444		
RSD	N/A			6			2		
F21D	0	0	N/A	19099	809	4	24011	587	2
F22D	0	0	N/A	17864	786	4	23453	578	2
F23D	0	0	N/A	18721	801	4	23031	575	2
MEAN F2	0			18561			23498		
STD DEV	0			517			401		
RSD	N/A			3			2		
F31D	0	0	N/A	16580	766	5	27316	618	2
F32D	0	0	N/A	17642	786	4	27658	623	2
F33D	0	0	N/A	17675	786	4	27258	619	2
MEAN F3	0			17299			27411		
STD DEV	0			509			176		
RSD	N/A			3			1		
F41D	0	0	N/A	16929	772	5	27488	619	2
F42D	0	0	N/A	19187	813	4	27358	623	2
F43D	0	0	N/A	16167	759	5	28052	624	2
MEAN F4	0			17428			27633		
STD DEV	0			1282			301		
RSD	N/A			7			1		
F51D	0	0	N/A	17583	784	4	27438	621	2
F52D	0	0	N/A	15697	747	5	25421	596	2
F53D	0	0	N/A	18676	803	4	26306	611	2
MEAN F5	0			17319			26388		
STD DEV	0			1230			825		
RSD	N/A			7			3		

STATION (Sample)	Tl ppm	Tl Std Dev	Tl RSD	Mn ppm	Mn Std Dev	Mn RSD	Fe ppm	Fe Std Dev	Fe RSD
D11D	3996	282	7	1113	227	20	52424	718	1
D12D	4588	278	6	564	205	36	50698	706	1
D13D	4886	290	6	1308	242	19	52900	726	1
MEAN D1	4490			995			52007		
STD DEV	370			315			946		
RSD	8			32			2		
D21D	4633	280	6	767	213	28	51324	713	1
D22D	4134	285	7	1039	222	21	49963	703	1
D23D	4233	278	7	1112	224	20	50564	706	1
MEAN D2	4333			973			50617		
STD DEV	216			148			557		
RSD	5			15			1		
D31D	3471	278	8	690	202	29	44238	658	1
D32D	4757	283	6	1236	230	19	44165	661	1
D33D	4254	271	6	905	211	23	42730	646	2
MEAN D3	4161			944			43711		
STD DEV	529			225			694		
RSD	13			24			2		
D41D	2897	234	8	1100	208	19	23123	472	2
D42D	2503	230	9	812	188	23	24137	480	2
D43D	3124	232	7	875	194	22	24920	489	2
MEAN D4	2841			929			24060		
STD DEV	257			124			736		
RSD	9			13			3		
D51D	2765	226	8	597	184	31	23708	475	2
D52D	2745	218	8	605	178	29	22315	459	2
D53D	2862	221	8	618	179	29	22086	455	2
MEAN D5	2791			607			22703		
STD DEV	51			9			717		
RSD	2			1			3		

STATION (Sample)	Tl ppm	Tl Std Dev	Tl RSD	Mn ppm	Mn Std Dev	Mn RSD	Fe ppm	Fe Std Dev	Fe RSD
E11D	4180	268	6	1037	220	21	43660	662	2
E12D	3820	265	7	706	209	30	43350	660	2
E13D	3946	264	7	877	210	24	43593	659	2
MEAN E1	3982			873			43534		
STD DEV	149			135			133		
RSD	4			15			0		
E21D	4433	780	18	516	202	39	49335	698	1
E22D	4502	280	6	497	195	39	48818	693	1
E23D	4229	280	7	1274	235	18	49096	696	1
MEAN E2	4388			762			49083		
STD DEV	116			362			211		
RSD	3			47			0		
E31D	3839	261	7	875	207	24	40022	624	2
E32D	4054	265	7	775	205	26	40691	630	2
E33D	3805	267	7	994	211	21	39655	622	2
MEAN E3	3899			881			40123		
STD DEV	110			90			429		
RSD	3			10			1		
E41D	4272	282	7	1023	219	21	47032	680	1
E42D	3916	267	7	757	206	27	45847	671	1
E43D	3757	272	7	801	203	25	45050	661	1
MEAN E4	3982			860			45976		
STD DEV	215			116			814		
RSD	5			14			2		
E51D	2941	230	8	705	186	26	27165	508	2
E52D	3171	250	8	730	190	26	27709	515	2
E53D	3545	247	7	1014	205	20	27858	516	2
MEAN E5	3219			816			27577		
STD DEV	249			140			298		
RSD	8			17			1		

STATION (Sample)	Tl ppm	Tl Std Dev	Tl RSD	Mn ppm	Mn Std Dev	Mn RSD	Fe ppm	Fe Std Dev	Fe RSD
F11D	3276	243	7	731	188	26	26005	495	2
F12D	2362	227	10	623	177	28	25200	486	2
F13D	2989	243	8	360	167	46	26595	502	2
MEAN F1	2876			571			25933		
STD DEV	382			156			572		
RSD	13			27			2		
F21D	2704	226	8	719	182	25	19707	431	2
F22D	2787	220	8	909	193	21	21920	454	2
F23D	2566	220	9	677	182	27	21099	446	2
MEAN F2	2686			768			20909		
STD DEV	91			101			913		
RSD	3			13			4		
F31D	2551	216	8	745	185	25	20412	438	2
F32D	2324	218	9	691	183	26	20653	442	2
F33D	2502	218	9	851	189	22	20274	438	2
MEAN F3	2459			762			20446		
STD DEV	98			66			157		
RSD	4			9			1		
F41D	2299	210	9	660	177	27	19184	425	2
F42D	2636	214	8	286	160	56	20794	444	2
F43D	2345	211	9	355	155	44	18160	412	2
MEAN F4	2427			434			19379		
STD DEV	149			163			1084		
RSD	6			37			6		
F51D	2218	222	10	746	183	25	20748	442	2
F52D	2155	208	10	546	171	31	20102	433	2
F53D	2570	218	8	641	181	28	21152	448	2
MEAN F5	2314			644			20667		
STD DEV	183			82			432		
RSD	8			13			2		

STATION (Sample)	Co ppm	Co Std Dev	Co RSD	Ni ppm	Ni Std Dev	Ni RSD	Cu ppm	Cu Std Dev	Cu RSD
D11D	262	231	88	0	0	N/A	310	46	15
D12D	0	0	N/A	0	0	N/A	172	40	23
D13D	236	233	99	0	0	N/A	271	45	17
MEAN D1	166			0			251		
STD DEV	118			0			58		
RSD	71			N/A			23		
D21D	515	233	45	0	0	N/A	46	33	72
D22D	0	0	N/A	0	0	N/A	38	33	87
D23D	0	0	N/A	94	60	64	0	0	N/A
MEAN D2	172			31			28		
STD DEV	243			44			20		
RSD	141			141			72		
D31D	0	0	N/A	0	0	N/A	94	35	37
D32D	226	214	95	0	0	N/A	108	36	33
D33D	0	0	N/A	0	0	N/A	151	38	25
MEAN D3	75			0			118		
STD DEV	107			0			24		
RSD	141			N/A			21		
D41D	0	0	N/A	0	0	N/A	32	29	91
D42D	0	0	N/A	0	0	N/A	0	0	N/A
D43D	0	0	N/A	0	0	N/A	0	0	N/A
MEAN D4	0			0			11		
STD DEV	0			0			15		
RSD	N/A			N/A			141		
D51D	0	0	N/A	0	0	N/A	0	0	N/A
D52D	177	157	89	0	0	N/A	44	30	68
D53D	0	0	N/A	0	0	N/A	0	0	N/A
MEAN D5	59			0			15		
STD DEV	83			0			21		
RSD	141			N/A			141		

STATION (Sample)	Co ppm	Co Std Dev	Co RSD	Ni ppm	Ni Std Dev	Ni RSD	Cu ppm	Cu Std Dev	Cu RSD
E11D	0	0	N/A	0	0	N/A	216	42	19
E12D	216	214	99	0	0	N/A	226	42	19
E13D	0	0	N/A	0	0	N/A	211	41	19
MEAN E1	72			0			218		
STD DEV	102			0			6		
RSD	141			N/A			3		
E21D	0	0	N/A	0	0	N/A	384	49	13
E22D	0	0	N/A	0	0	N/A	419	50	12
E23D	0	0	N/A	0	0	N/A	446	51	11
MEAN E2	0			0			416		
STD DEV	0			0			25		
RSD	N/A			N/A			6		
E31D	0	0	N/A	0	0	N/A	72	33	46
E32D	248	206	83	0	0	N/A	72	34	47
E33D	296	205	69	0	0	N/A	93	34	37
MEAN E3	181			0			79		
STD DEV	130			0			10		
RSD	72			N/A			13		
E41D	643	226	35	0	0	N/A	204	41	20
E42D	0	0	N/A	116	60	52	69	34	49
E43D	419	217	52	0	0	N/A	158	38	24
MEAN E4	354			39			144		
STD DEV	266			55			56		
RSD	75			141			39		
E51D	0	0	N/A	0	0	N/A	0	0	N/A
E52D	0	0	N/A	0	0	N/A	33	30	91
E53D	0	0	N/A	0	0	N/A	0	0	N/A
MEAN E5	0			0			11		
STD DEV	0			0			16		
RSD	N/A			N/A			141		

STATION (Sample)	Co ppm	Co Std Dev	Co RSD	Ni ppm	Ni Std Dev	Ni RSD	Cu ppm	Cu Std Dev	Cu RSD
F11D	0	0	N/A	0	0	N/A	0	0	N/A
F12D	203	165	81	0	0	N/A	37	29	78
F13D	0	0	N/A	0	0	N/A	48	31	65
MEAN F1	68			0			28		
STD DEV	96			0			21		
RSD	141			N/A			72		
F21D	270	152	56	0	0	N/A	46	30	65
F22D	0	0	N/A	0	0	N/A	0	0	N/A
F23D	0	0	N/A	0	0	N/A	0	0	N/A
MEAN F2	90			0			15		
STD DEV	127			0			22		
RSD	141			N/A			141		
F31D	0	0	N/A	0	0	N/A	0	0	N/A
F32D	0	0	N/A	0	0	N/A	31	29	94
F33D	0	0	N/A	0	0	N/A	0	0	N/A
MEAN F3	0			0			10		
STD DEV	0			0			15		
RSD	N/A			N/A			141		
F41D	0	0	N/A	0	0	N/A	82	31	38
F42D	0	0	N/A	0	0	N/A	36	29	81
F43D	0	0	N/A	0	0	N/A	0	0	N/A
MEAN F4	0			0			39		
STD DEV	0			0			34		
RSD	N/A			N/A			85		
F51D	0	0	N/A	0	0	N/A	49	30	61
F52D	0	0	N/A	0	0	N/A	0	0	N/A
F53D	0	0	N/A	0	0	N/A	35	29	83
MEAN F5	0			0			28		
STD DEV	0			0			21		
RSD	N/A			N/A			74		

STATION (Sample)	Zn ppm	Zn Std Dev	Zn RSD	As ppm	As Std Dev	As RSD	Se ppm	Se Std Dev	Se RSD
D11D	313	37	12	0	0	N/A	0	0	N/A
D12D	303	36	12	61	19	31	0	0	N/A
D13D	328	38	12	51	20	39	0	0	N/A
MEAN D1	315			37			0		
STD DEV	10			27			0		
RSD	3			72			N/A		
D21D	194	33	17	0	0	N/A	0	0	
D22D	144	30	21	47	18	38	0	0	N/A
D23D	168	31	18	25	17	68	0	0	N/A
MEAN D2	169			24			0		
STD DEV	20			19			0		
RSD	12			80			N/A		
D31D	152	31	20	30	19	63	0	0	N/A
D32D	232	34	15	0	0	N/A	0	0	N/A
D33D	151	31	21	58	18	31	0	0	N/A
MEAN D3	178			29			0		
STD DEV	38			24			0		
RSD	21			81			N/A		
D41D	102	27	26	0	0	N/A	0	0	N/A
D42D	167	30	18	19	15	79	0	0	N/A
D43D	72	26	36	35	17	49	0	0	N/A
MEAN D4	114			18			0		
STD DEV	40			14			0		
RSD	35			79			N/A		
D51D	119	28	24	52	17	33	0	0	N/A
D52D	122	28	23	0	0	N/A	0	0	N/A
D53D	95	26	27	18	15	83	10	10	100
MEAN D5	112			23			3		
STD DEV	12			22			5		
RSD	11			92			141		

STATION (Sample)	Zn ppm	Zn Std Dev	Zn RSD	As ppm	As Std Dev	As RSD	Se ppm	Se Std Dev	Se RSD
E11D	330	38	12	33	19	58	0	0	N/A
E12D	319	37	12	0	0	N/A	0	0	N/A
E13D	306	36	12	54	19	35	0	0	N/A
MEAN E1	318			29			0		
STD DEV	10			22			0		
RSD	3			77			N/A		
E21D	290	36	12	71	19	27	0	0	N/A
E22D	341	38	11	36	19	53	0	0	N/A
E23D	242	35	14	65	19	29	0	0	N/A
MEAN E2	291			57			0		
STD DEV	40			15			0		
RSD	14			27			N/A		
E31D	169	31	18	28	17	61	0	0	N/A
E32D	143	30	21	53	18	34	16	11	69
E33D	177	31	18	74	18	24	0	0	N/A
MEAN E3	163			52			5		
STD DEV	15			19			8		
RSD	9			36			141		
E41D	233	34	15	47	19	40	13	11	85
E42D	264	35	13	0	0	N/A	0	0	N/A
E43D	115	29	25	53	19	36	0	0	N/A
MEAN E4	204			33			4		
STD DEV	64			24			6		
RSD	31			71			141		
E51D	168	29	17	49	16	33	0	0	N/A
E52D	167	30	18	0	0	N/A	11	10	91
E53D	138	29	21	65	17	26	0	0	N/A
MEAN E5	158			38			4		
STD DEV	14			28			5		
RSD	9			73			141		

STATION (Sample)	Zn ppm	Zn Std Dev	Zn RSD	As ppm	As Std Dev	As RSD	Se ppm	Se Std Dev	Se RSD
F11D	163	29	18	0	0	N/A	0	0	N/A
F12D	148	29	20	28	16	57	0	0	N/A
F13D	116	28	24	31	17	55	0	0	N/A
MEAN F1	142			20			0		
STD DEV	20			14			0		
RSD	14			71			N/A		
F21D	82	26	32	54	16	30	0	0	N/A
F22D	156	29	19	37	15	41	0	0	N/A
F23D	97	26	27	0	0	N/A	0	0	N/A
MEAN F2	112			30			0		
STD DEV	32			23			0		
RSD	29			74			N/A		
F31D	101	27	27	0	0	N/A	0	0	N/A
F32D	67	26	39	39	16	41	0	0	N/A
F33D	87	26	30	41	16	39	0	0	N/A
MEAN F3	85			27			0		
STD DEV	14			19			0		
RSD	16			71			N/A		
F41D	71	25	35	0	0	N/A	0	0	N/A
F42D	152	29	19	24	15	63	14	10	71
F43D	128	27	21	23	15	65	0	0	N/A
MEAN F4	117			16			5		
STD DEV	34			11			7		
RSD	29			71			141		
F51D	150	29	19	0	0	N/A	0	0	N/A
F52D	102	27	26	52	17	33	0	0	N/A
F53D	144	29	20	75	17	23	0	0	N/A
MEAN F5	132			42			0		
STD DEV	21			31			0		
RSD	16			74			N/A		

STATION (Sample)	Sr ppm	Sr Std Dev	Sr RSD	Zr ppm	Zr Std Dev	Zr RSD	Mo ppm	Mo Std Dev	Mo RSD
D11D	173	7	4	131	6	5	5	3	60
D12D	153	9	6	134	6	4	5	3	60
D13D	165	9	5	142	6	4	6	3	50
MEAN D1	164			136			5		
STD DEV	8			5			0		
RSD	5			3			9		
D21D	156	9	6	109	5	5	9	3	33
D22D	143	8	6	104	5	5	4	3	75
D23D	136	8	6	118	5	4	0	0	N/A
MEAN D2	145			110			4		
STD DEV	8			6			4		
RSD	6			5			85		
D31D	202	10	5	146	6	4	4	3	75
D32D	195	10	5	131	6	5	3	3	100
D33D	190	9	5	126	5	4	3	3	100
MEAN D3	196			134			3		
STD DEV	5			8			0		
RSD	3			6			14		
D41D	292	11	4	144	6	4	0	0	N/A
D42D	298	11	4	125	5	4	6	2	33
D43D	283	11	4	122	5	4	0	0	N/A
MEAN D4	291			130			2		
STD DEV	6			10			3		
RSD	2			7			141		
D51D	280	10	4	151	6	4	3	2	67
D52D	259	10	4	144	5	3	2	2	100
D53D	273	10	4	146	5	3	4	2	50
MEAN D5	271			147			3		
STD DEV	9			3			1		
RSD	3			2			27		

STATION (Sample)	Sr ppm	Sr Std Dev	Sr RSD	Zr ppm	Zr Std Dev	Zr RSD	Mo ppm	Mo Std Dev	Mo RSD
E11D	232	10	4	137	6	4	10	3	30
E12D	231	10	4	148	6	4	16	3	19
E13D	231	10	4	135	6	4	17	3	18
MEAN E1	231			140			14		
STD DEV	0			6			3		
RSD	0			4			22		
E21D	153	9	6	118	5	4	3	3	100
E22D	164	9	5	113	5	4	4	3	75
E23D	160	9	6	111	5	5	7	3	43
MEAN E2	159			114			5		
STD DEV	5			3			2		
RSD	3			3			36		
E31D	193	9	5	133	5	4	7	3	43
E32D	212	10	5	119	5	4	0	0	N/A
E33D	218	10	5	118	5	4	5	2	40
MEAN E3	208			123			4		
STD DEV	11			7			3		
RSD	5			6			74		
E41D	167	9	5	118	5	4	0	0	N/A
E42D	179	9	5	111	5	5	5	3	60
E43D	166	9	5	122	5	4	4	3	75
MEAN E4	171			117			3		
STD DEV	6			5			2		
RSD	3			4			72		
E51D	255	10	4	131	5	4	0	0	N/A
E52D	258	10	4	166	6	4	0	0	N/A
E53D	266	10	4	148	6	4	3	2	67
MEAN E5	260			148			1		
STD DEV	5			14			1		
RSD	2			10			141		

STATION (Sample)	Sr ppm	Sr Std Dev	Sr RSD	Zr ppm	Zr Std Dev	Zr RSD	Mo ppm	Mo Std Dev	Mo RSD
F11D	239	10	4	118	5	4	0	0	N/A
F12D	246	10	4	129	5	4	0	0	N/A
F13D	245	10	4	123	5	4	3	2	67
MEAN F1	243			123			1		
STD DEV	3			4			1		
RSD	1			4			141		
F21D	275	10	4	122	5	4	0	0	N/A
F22D	254	10	4	118	5	4	4	2	50
F23D	245	10	4	132	5	4	0	0	N/A
MEAN F2	258			124			1		
STD DEV	13			6			2		
RSD	5			5			141		
F31D	269	10	4	149	5	3	5	2	40
F32D	280	10	4	113	5	4	2	2	100
F33D	273	10	4	136	5	4	0	0	N/A
MEAN F3	274			133			2		
STD DEV	5			15			2		
RSD	2			11			88		
F41D	264	10	4	111	5	5	0	0	N/A
F42D	279	10	4	116	5	4	0	0	N/A
F43D	282	10	4	118	5	4	0	0	N/A
MEAN F4	275			115			0		
STD DEV	8			3			0		
RSD	3			3			N/A		
F51D	270	10	4	90	5	6	4	2	50
F52D	276	10	4	97	5	5	0	0	N/A
F53D	286	11	4	90	5	6	5	2	40
MEAN F5	277			92			3		
STD DEV	7			3			2		
RSD	2			4			72		

STATION (Sample)	Hg ppm	Hg Std Dev	Hg RSD	Pb ppm	Pb Std Dev	Pb RSD	Rb ppm	Rb Std Dev	Rb RSD
D11D	0	0	N/A	32	11	34	119	11	9
D12D	0	0	N/A	16	12	75	125	11	9
D13D	0	0	N/A	25	13	52	98	11	11
MEAN D1	0			24			114		
STD DEV	0			7			12		
RSD	N/A			27			10		
D21D	0	0	N/A	27	12	44	123	11	9
D22D	0	0	N/A	0	0	N/A	125	11	9
D23D	0	0	N/A	13	11	85	110	11	10
MEAN D2	0			13			119		
STD DEV	0			11			7		
RSD	N/A			83			6		
D31D	0	0	N/A	28	13	46	97	10	10
D32D	0	0	N/A	40	13	33	80	9	11
D33D	0	0	N/A	0	0	N/A	80	10	13
MEAN D3	0			23			86		
STD DEV	0			17			8		
RSD	N/A			74			9		
D41D	0	0	N/A	16	11	69	45	8	18
D42D	0	0	N/A	0	0	N/A	53	8	15
D43D	0	0	N/A	12	10	83	62	8	13
MEAN D4	0			9			53		
STD DEV	0			7			7		
RSD	N/A			73			13		
D51D	0	0	N/A	0	0	N/A	76	8	11
D52D	0	0	N/A	0	0	N/A	72	8	11
D53D	0	0	N/A	0	0	N/A	70	8	11
MEAN D5	0			0			73		
STD DEV	0			0			2		
RSD	N/A			N/A			3		

STATION (Sample)	Hg ppm	Hg Std Dev	Hg RSD	Pb ppm	Pb Std Dev	Pb RSD	Rb ppm	Rb Std Dev	Rb RSD
E11D	0	0	N/A	36	13	36	104	10	10
E12D	0	0	N/A	48	14	29	87	10	11
E13D	0	0	N/A	0	0	N/A	96	10	10
MEAN E1	0			28			96		
STD DEV	0			20			7		
RSD	N/A			73			7		
E21D	0	0	N/A	0	0	N/A	117	11	9
E22D	0	0	N/A	25	12	48	91	10	11
E23D	0	0	N/A	15	12	80	123	11	9
MEAN E2	0			13			110		
STD DEV	0			10			14		
RSD	N/A			77			13		
E31D	0	0	N/A	0	0	N/A	79	9	11
E32D	0	0	N/A	0	0	N/A	92	10	11
E33D	0	0	N/A	0	0	N/A	102	10	10
MEAN E3	0			0			91		
STD DEV	0			0			9		
RSD	N/A			N/A			10		
E41D	0	0	N/A	15	12	80	94	10	11
E42D	0	0	N/A	32	13	41	98	10	10
E43D	0	0	N/A	14	12	86	109	10	9
MEAN E4	0			20			100		
STD DEV	0			8			6		
RSD	N/A			41			6		
E51D	0	0	N/A	0	0	N/A	62	8	13
E52D	0	0	N/A	0	0	N/A	73	9	12
E53D	0	0	N/A	0	0	N/A	67	9	13
MEAN E5	0			0			67		
STD DEV	0			0			4		
RSD	N/A			N/A			7		

STATION (Sample)	Hg ppm	Hg Std Dev	Hg RSD	Pb ppm	Pb Std Dev	Pb RSD	Rb ppm	Rb Std Dev	Rb RSD
F11D	0	0	N/A	14	10	71	74	9	12
F12D	0	0	N/A	0	0	N/A	61	8	13
F13D	24	23	96	15	11	73	65	8	12
MEAN F1	8			10			67		
STD DEV	11			7			5		
RSD	141			71			8		
F21D	0	0	N/A	0	0	N/A	55	8	15
F22D	0	0	N/A	0	0	N/A	55	8	15
F23D	0	0	N/A	12	10	83	59	8	14
MEAN F2	0			4			56		
STD DEV	0			6			2		
RSD	N/A			141			3		
F31D	0	0	N/A	0	0	N/A	40	7	18
F32D	0	0	N/A	0	0	N/A	58	8	14
F33D	0	0	N/A	0	0	N/A	60	8	13
MEAN F3	0			0			53		
STD DEV	0			0			9		
RSD	N/A			N/A			17		
F41D	0	0	N/A	15	10	67	51	8	16
F42D	0	0	N/A	0	0	N/A	53	7	13
F43D	0	0	N/A	12	10	83	47	8	17
MEAN F4	0			9			50		
STD DEV	0			6			2		
RSD	N/A			72			5		
F51D	27	23	85	19	11	58	52	8	15
F52D	0	0	N/A	15	10	67	59	8	14
F53D	34	23	68	0	0	N/A	54	8	15
MEAN F5	20			11			55		
STD DEV	15			8			3		
RSD	72			72			5		

STATION (Sample)	Cd ppm	Cd Std Dev	Cd RSD	Ba ppm	Ba Std Dev	Ba RSD	Ag ppm	Ag Std Dev	Ag RSD
D11D	0	0	N/A	257	9	4	0	0	N/A
D12D	0	0	N/A	223	9	4	60	23	38
D13D	56	40	71	286	10	3	33	25	76
MEAN D1	19			255			31		
STD DEV	26			26			25		
RSD	141			10			79		
D21D	0	0	N/A	208	8	4	48	22	46
D22D	0	0	N/A	219	8	4	56	23	41
D23D	0	0	N/A	183	8	4	37	21	57
MEAN D2	0			203			47		
STD DEV	0			15			8		
RSD	N/A			7			17		
D31D	61	37	61	248	9	4	75	34	45
D32D	123	38	31	270	9	3	56	24	43
D33D	0	0	N/A	276	9	3	52	24	46
MEAN D3	61			265			61		
STD DEV	50			12			10		
RSD	82			5			16		
D41D	0	0	N/A	363	10	3	63	24	38
D42D	111	34	31	305	9	3	93	22	24
D43D	58	33	57	272	9	3	26	20	77
MEAN D4	56			313			61		
STD DEV	45			38			27		
RSD	80			12			45		
D51D	59	34	58	297	9	3	98	22	22
D52D	114	34	30	302	9	3	65	21	32
D53D	0	0	N/A	311	9	3	62	21	34
MEAN D5	58			303			75		
STD DEV	47			6			16		
RSD	81			2			22		

STATION (Sample)	Cd ppm	Cd Std Dev	Cd RSD	Ba ppm	Ba Std Dev	Ba RSD	Ag ppm	Ag Std Dev	Ag RSD
E11D	43	37	86	254	9	4	59	23	39
E12D	68	36	53	247	9	4	53	23	43
E13D	98	33	34	192	8	4	0	0	N/A
MEAN E1	70			231			37		
STD DEV	22			28			27		
RSD	32			12			71		
E21D	0	0	N/A	208	8	4	35	22	63
E22D	66	34	52	191	8	4	70	22	31
E23D	53	36	68	214	8	4	50	22	44
MEAN E2	40			204			52		
STD DEV	29			10			14		
RSD	72			5			28		
E31D	36	31	86	188	8	4	58	20	34
E32D	0	0	N/A	281	9	3	0	0	N/A
E33D	103	32	31	200	8	4	0	0	N/A
MEAN E3	46			223			19		
STD DEV	43			41			27		
RSD	92			19			141		
E41D	60	34	57	218	8	4	0	0	N/A
E42D	0	0	N/A	182	8	4	0	0	N/A
E43D	64	34	53	207	8	4	43	21	49
MEAN E4	41			202			14		
STD DEV	29			15			20		
RSD	71			7			141		
E51D	0	0	N/A	243	8	3	36	20	56
E52D	42	36	86	324	10	3	75	23	31
E53D	0	0	N/A	298	9	3	32	22	69
MEAN E5	14			288			48		
STD DEV	20			34			19		
RSD	141			12			41		

STATION (Sample)	Cd ppm	Cd Std Dev	Cd RSD	Ba ppm	Ba Std Dev	Ba RSD	Ag ppm	Ag Std Dev	Ag RSD
F11D	43	33	77	280	9	3	33	21	64
F12D	45	30	67	253	8	3	40	19	48
F13D	59	32	54	285	9	3	29	20	69
MEAN F1	49			273			34		
STD DEV	7			14			5		
RSD	15			5			13		
F21D	52	34	65	356	10	3	68	22	32
F22D	50	34	68	331	10	3	88	22	25
F23D	58	32	55	301	9	3	66	21	32
MEAN F2	53			329			74		
STD DEV	3			22			10		
RSD	6			7			13		
F31D	115	34	30	295	9	3	91	22	24
F32D	81	35	43	339	10	3	47	22	47
F33D	128	33	26	307	9	3	76	21	28
MEAN F3	108			314			71		
STD DEV	20			19			18		
RSD	18			6			26		
F41D	40	32	80	297	9	3	59	20	34
F42D	129	34	26	301	9	3	70	25	21
F43D	0	0	N/A	295	9	3	53	20	38
MEAN F4	56			298			61		
STD DEV	54			2			7		
RSD	96			1			12		
F51D	59	35	59	341	10	3	52	22	42
F52D	0	0	N/A	341	10	3	66	22	33
F53D	0	0	N/A	344	10	3	0	0	N/A
MEAN F5	20			342			39		
STD DEV	28			1			28		
RSD	141			0			72		

STATION (Sample)	U ppm	U Std Dev	U RSD	Th ppm	Th Std Dev	Th RSD	Sb ppm	Sb Std Dev	Sb RSD
D11D	0	0	N/A	15	4	27	0	0	N/A
D12D	0	0	N/A	10	4	40	13	13	100
D13D	0	0	N/A	10	4	40	20	14	70
MEAN D1	0			12			11		
STD DEV	0			2			8		
RSD	N/A			20			75		
D21D	0	0	N/A	0	0	N/A	23	13	57
D22D	0	0	N/A	14	4	29	0	0	N/A
D23D	8	6	75	0	0	N/A	23	12	52
MEAN D2	3			5			15		
STD DEV	4			7			11		
RSD	141			141			71		
D31D	0	0	N/A	12	4	33	0	0	N/A
D32D	0	0	N/A	10	4	40	0	0	N/A
D33D	10	6	60	10	4	40	0	0	N/A
MEAN D3	3			11			0		
STD DEV	5			1			0		
RSD	141			9			N/A		
D41D	12	6	50	4	4	100	15	14	93
D42D	0	0	N/A	0	0	N/A	0	0	N/A
D43D	10	6	60	4	4	100	0	0	N/A
MEAN D4	7			3			5		
STD DEV	5			2			7		
RSD	72			71			141		
D51D	0	0	N/A	10	4	40	0	0	N/A
D52D	0	0	N/A	0	0	N/A	0	0	N/A
D53D	0	0	N/A	0	0	N/A	0	0	N/A
MEAN D5	0			3			0		
STD DEV	0			5			0		
RSD	N/A			141			N/A		

STATION (Sample)	U ppm	U Std Dev	U RSD	Th ppm	Th Std Dev	Th RSD	Sb ppm	Sb Std Dev	Sb RSD
E11D	0	0	N/A	4	4	100	0	0	N/A
E12D	0	0	N/A	9	4	44	0	0	N/A
E13D	0	0	N/A	8	4	50	0	0	N/A
MEAN E1	0			7			0		
STD DEV	0			2			0		
RSD	N/A			31			N/A		
E21D	0	0	N/A	7	4	57	0	0	N/A
E22D	9	6	67	8	4	50	29	13	45
E23D	0	0	N/A	8	4	50	0	0	N/A
MEAN E2	3			8			10		
STD DEV	4			0			14		
RSD	141			6			141		
E31D	0	0	N/A	0	0	N/A	0	0	N/A
E32D	0	0	N/A	12	4	33	0	0	N/A
E33D	0	0	N/A	5	4	80	0	0	N/A
MEAN E3	0			6			0		
STD DEV	0			5			0		
RSD	N/A			87			N/A		
E41D	0	0	N/A	13	4	31	0	0	N/A
E42D	0	0	N/A	13	4	31	0	0	N/A
E43D	0	0	N/A	15	4	27	0	0	N/A
MEAN E4	0			14			0		
STD DEV	0			1			0		
RSD	N/A			7			N/A		
E51D	0	0	N/A	5	4	80	16	12	75
E52D	0	0	N/A	8	4	50	0	0	N/A
E53D	0	0	N/A	9	4	44	26	13	50
MEAN E5	0			7			14		
STD DEV	0			2			11		
RSD	N/A			23			76		

STATION (Sample)	U ppm	U Std Dev	U RSD	Th ppm	Th Std Dev	Th RSD	Sb ppm	Sb Std Dev	Sb RSD
F11D	0	0	N/A	0	0	N/A	0	0	N/A
F12D	0	0	N/A	6	4	67	0	0	N/A
F13D	0	0	N/A	12	4	33	0	0	N/A
MEAN F1	0			6			0		
STD DEV	0			5			0		
RSD	N/A			82			N/A		
F21D	0	0	N/A	0	0	N/A	0	0	N/A
F22D	0	0	N/A	0	0	N/A	0	0	N/A
F23D	0	0	N/A	0	0	N/A	0	0	N/A
MEAN F2	0			0			0		
STD DEV	0			0			0		
RSD	N/A			N/A			N/A		
F31D	0	0	N/A	0	0	N/A	0	0	N/A
F32D	0	0	N/A	9	4	44	0	0	N/A
F33D	0	0	N/A	0	0	N/A	0	0	N/A
MEAN F3	0			3			0		
STD DEV	0			4			0		
RSD	N/A			141			N/A		
F41D	0	0	N/A	0	0	N/A	0	0	N/A
F42D	0	0	N/A	0	0	N/A	0	0	N/A
F43D	12	6	50	0	0	N/A	0	0	N/A
MEAN F4	4			0			0		
STD DEV	6			0			0		
RSD	141			N/A			N/A		
F51D	0	0	N/A	14	4	29	0	0	N/A
F52D	0	0	N/A	9	4	44	0	0	N/A
F53D	0	0	N/A	14	4	29	0	0	N/A
MEAN F5	0			12			0		
STD DEV	0			2			0		
RSD	N/A			19			N/A		

STATION (Sample)	Sn ppm	Sn Std Dev	Sn RSD
D11D	17	11	65
D12D	17	11	65
D13D	0	0	N/A
MEAN D1	11		
STD DEV	8		
RSD	71		
D21D	0	0	N/A
D22D	0	0	N/A
D23D	0	0	N/A
MEAN D2	0		
STD DEV	0		
RSD	N/A		
D31D	0	0	N/A
D32D	0	0	N/A
D33D	17	11	65
MEAN D3	6		
STD DEV	8		
RSD	141		
D41D	14	11	79
D42D	0	0	N/A
D43D	0	0	N/A
MEAN D4	5		
STD DEV	7		
RSD	141		
D51D	0	0	N/A
D52D	0	0	N/A
D53D	0	0	N/A
MEAN D5	0		
STD DEV	0		
RSD	N/A		

STATION (Sample)	Sn ppm	Sn Std Dev	Sn RSD
E11D	0	0	N/A
E12D	0	0	N/A
E13D	16	9	56
MEAN E1	5		
STD DEV	8		
RSD	141		
E21D	16	10	63
E22D	0	0	N/A
E23D	0	0	N/A
MEAN E2	5		
STD DEV	8		
RSD	141		
E31D	13	9	69
E32D	12	10	83
E33D	23	9	39
MEAN E3	16		
STD DEV	5		
RSD	31		
E41D	22	10	45
E42D	18	9	50
E43D	0	0	N/A
MEAN E4	13		
STD DEV	10		
RSD	72		
E51D	19	9	47
E52D	13	10	77
E53D	0	0	N/A
MEAN E5	11		
STD DEV	8		
RSD	74		

STATION (Sample)	Sn ppm	Sn Std Dev	Sn RSD
F11D	0	0	N/A
F12D	0	0	N/A
F13D	16	9	56
MEAN F1	5		
STD DEV	8		
RSD	141		
F21D	0	0	N/A
F22D	0	0	N/A
F23D	0	0	N/A
MEAN F2	0		
STD DEV	0		
RSD	N/A		
F31D	0	0	N/A
F32D	0	0	N/A
F33D	0	0	N/A
MEAN F3	0		
STD DEV	0		
RSD	N/A		
F41D	0	0	N/A
F42D	0	0	N/A
F43D	0	0	N/A
MEAN F4	0		
STD DEV	0		
RSD	N/A		
F51D	0	0	N/A
F52D	0	0	N/A
F53D	32	10	31
MEAN F5	11		
STD DEV	15		
RSD	141		

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The accuracy, precision, and performance of a field-portable x-ray fluorescence (XRF) spectrometer was evaluated for marine samples. The XRF spectrometer can perform well on board survey vessels and provide a precise, near-real-time determination of metals at levels indicative of pollution in marine sediments obtained by sediment grabs. The resulting capability for on-site decision-making can provide guidance for mapping strategies and detailed sampling.

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